MAR 11 1910

JOURNAL OF ELECTRICITY

POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

Entered as second-class matter May 7, 1906, at the Post Office at San Francisco, Cal., under the Act of Congress March 3, 1879

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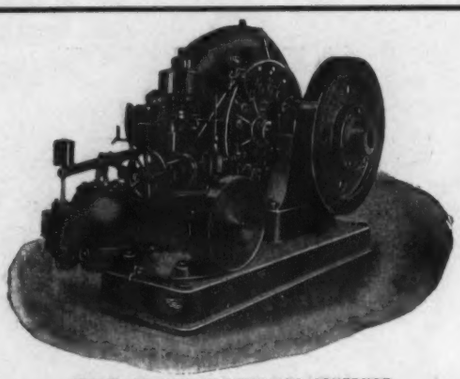

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JOURNAL OF ELECTRICITY
POWER AND GAS
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VOLUME XXIV SAN FRANCISCO, MARCH 5, 1910. NUMBER 10

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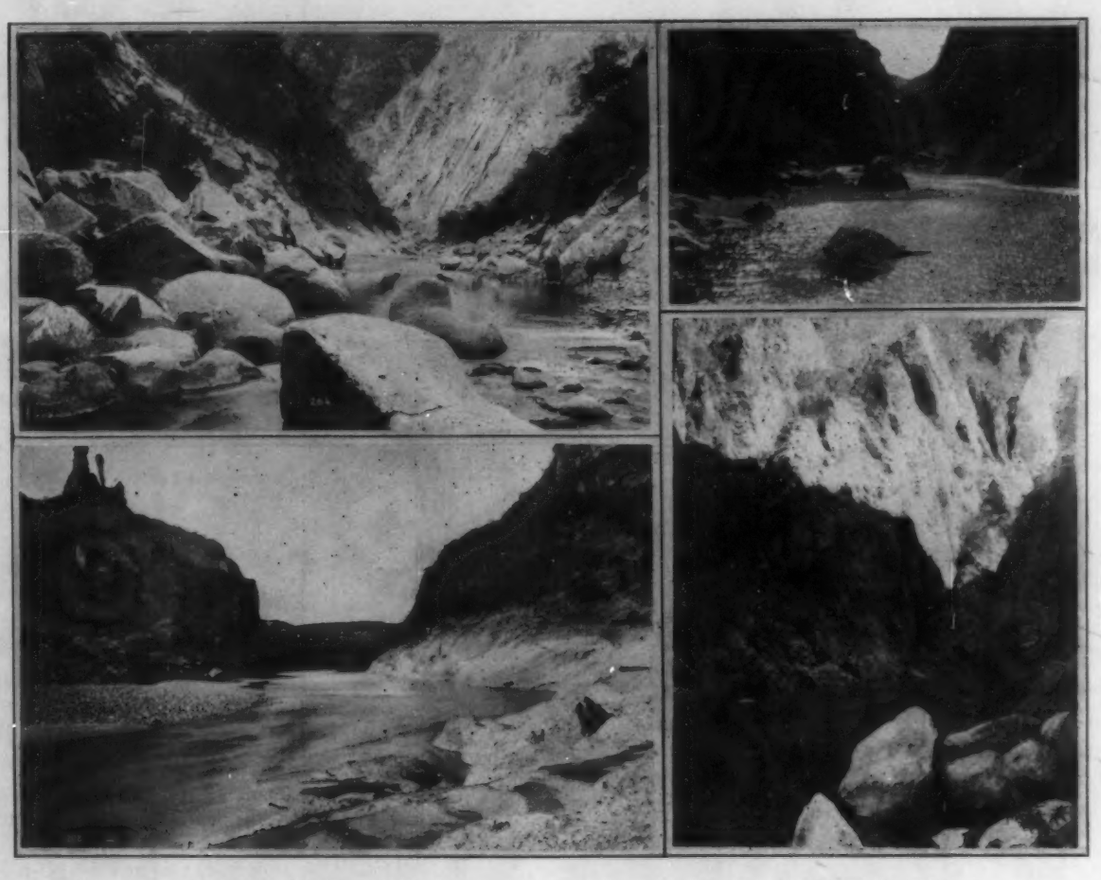
POWER POSSIBILITIES OF THE MAYO RIVER, MEXICO

BY R. M. JONES.

Careful examinations of the Mayo River in Northern Mexico made by the writer during 1908 and 1909 showed that it may be admirably adapted for power production. Perpetual power rights of this stream from its start at the confluence of the Moris and the Candamena at La Junta in Chihuahua throughout the 155 miles of its course to Navojoa in the foothills of Sonora, have been acquired from the Mexican government by the Mayo River Power & Land Company. The greatest part of the drainage area of the river lies in the high mountainous country in western Chihuahua and eastern Sonora. It carries an abundance of water to operate the proposed plants of the company to their full capacity, with the assistance of



La Junta Damsite.
Pilares Damsite.

Mayo Damsite.
San Luis Damsite.

the reservoir to be constructed in connection with each plant. As there are two rainy seasons in each year, both of which cause a flow sufficient to fill the reservoirs, the storage capacity required is only little more than half that required in climates having only one wet season, allowing for extra capacity to provide for a possible dry winter season.

Within the limits of the company's concession are four good dam-sites; one just below its source at La Junta; one at dam-site No. 1; another at a point 27½ miles below dam-site No. 1; and the last at Pilares, just above San Bernardo. This last dam-site is 40 miles above Navajoa, and about 35 miles over a smooth, level wagon road from Alamos, a town of about 15,000 people on a branch line of the Southern Pacific. These four dam-sites have an aggregate capacity of 40,000 h. p. net delivered. I have advised the company to build the first dam and power plant at Pilares, because of the ease and cheapness with which material for construction can be taken to that place, and because the entire capacity of this plant can be contracted for in advance by mining and industrial corporation of undoubted responsibility.

Three great trunk lines are now building through this region. The Southern Pacific or Harriman lines are already contructed and in operation lengthwise through the central portion of the States of Sonora and Sinaloa as far south as Mazatlan, and are expected to reach Guadalajara next year. Stillwell is building the Orient road across the southern portions of Chihuahua and Sonora. This road now crosses the Southern Pacific and the Fuerte River at San Blass, 83 miles south of the Mayo, and has established terminal and harbor facilities at Topolobampo on the Gulf. The Mexican-Northwestern Railway Company, a forty million dollar corporation backed by the Pearson syndicate, will build just north of Ocampo and will strike the Mayo river at a point just below San Bernardo, following this river down to Navojoa, forming junction with the Southern Pacific and possibly to the Gulf of California, where terminal and harbor facilities will be established to take care of the Central and South American trade.

There are four large American corporations that are now engaged in irrigating and colonizing vast tracts of land in the State of Sonora in the vicinity of the Mayo River. One of these concerns owns 100,000 acres, another 110,000, the Richardson Brothers and John Hays Hammond have 600,000 acres along the Yaqui river and between the Yaqui and Mayo rivers, and still another concern has purchased 1,000,000 acres upon which they have already established a town on the Gulf of California called Port Lobos. In the Sierra Madre mountains, tributary to the Mayo river, there are great mining camps whose mines have been worked for 200 years. These include Ocampo, Trinidad, the new gold camp of Sobia on the Mayo river, the new copper camp of Piedras Verdes, 25 miles from San Bernardo, which is being thoroughly tested in a most systematic manner with diamond drills by the Ray Consolidated Copper Mining Company, and a new copper camp about 50 miles from San Bernardo, whose surface showings are said to surpass even those of Piedras Verdes.

It is estimated that not more than two years will be required to complete the first dam and power plant, which will have a capacity of 10,000 h. p. The construction of the dams will render the Mayo river navigable in stages to a point beyond the coal deposits, and mines. This river will, after the three dams contemplated are constructed, furnish cheap water transportation for the ores of all the mining camps tributary to this stream. This advantage of transportation will follow from the construction of the dams without extra cost, just as by-products are obtained from manufacturing establishments.

The only construction involved in this first, the Pilares plant, consists in a steel faced and rock filled dam 320 ft. long at top, and 260 ft. across the bottom in a box canyon. It will be 151 ft. high with 600 ft. of spillway provided for independently and away from the dam; one large bleeder tunnel 1400 feet long bypassing the dam; one working tunnel lined for low pressure, valves, fittings and pipe connections in the tunnel; concrete and steel power house, containing four 2500 k. w. generators directly connected to water wheels having 1/3 overload capacity; transforming station and equipments; and line construction aggregating 120 miles—40 miles being the longest one contemplated at present.

The Pilares plant is located but 35 miles from Alamos, Sonora, which is at the terminus of a Southern Pacific branch line from Navojoa. There is an excellent wagon road between San Bernardo and Alamos, leaving but two miles additional to construct to Pilares dam. The total development will consist of dam, tunnel and power plant, all within the radius of 1200 feet.

Selenium is obtained principally in the anode muds or slimes of the electrolytic copper refineries. The American Smelters Securities plant at Baltimore, Md., the Perth Amboy and the Chrome, N. J., refineries all have made more or less selenium. The Baltimore and the Chrome refineries get their crude copper from many sources, but that handled at Perth Amboy comes almost exclusively from Butte, Mont. Great tonnages of copper are handled at each of the smelters and the selenium recovered represents only minute traces in the original ores. The anode slimes in the copper refineries contain a large percentage, in many cases 50 per cent or more, of gold and silver. The slimes are treated in very large cupellation furnaces, as large as the reverberatory furnaces which a comparatively few years ago were used for copper smelting. Selenium is collected in the flue dusts from this cupellation, and is recovered by processes which differ with the refinery and which are hardly to be considered as more than experimental.

Successful Poulsen tests have been conducted during the past month under the direction of C.F. Elwell of San Francisco between Sacramento and Stockton, in the central valley of California. These two cities are fifty miles apart, but telephonic communication without connecting wires has been successfully established. It is claimed that the articulation is much clearer than with the ordinary type of telephone and the sound intensity at the receiving end as great as at the sending.

THE WATT-HOUR METER.

BY WM. M. SHEPARD AND ALLEN G. JONES.

(Continued.)

CHAPTER II.

THE MEASUREMENT OF POWER.

The power in a direct current circuit is equal to the product of the electro motiveforce and the current; in other words, if I represents the current in amperes, and E, the e.m.f. in volts, then the

$$\text{Watts, } W = EI, \text{ or the kilowatts} = \frac{EI}{1000}$$

The power flowing in a direct current circuit can therefore be determined by the use of a voltmeter and an ammeter, or by one instrument, an indicating wattmeter, which will indicate the product of the volts and amperes.

The power flowing in an alternating current circuit is dependent not only upon the e.m.f. and the current, but also upon the power factor of the circuit. This is evident as is illustrated by Fig. 5, which shows

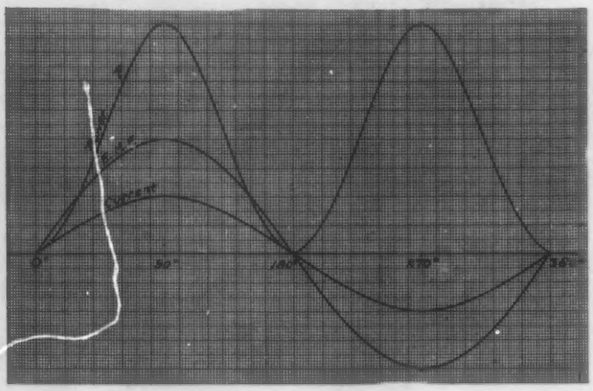


Fig. 5.

a sine wave of e.m.f and current at unity power factor. In Fig. 6 is shown the same current and e.m.f. but with a power factor of 50 per cent instead of unity. The instantaneous value of the power flowing in any

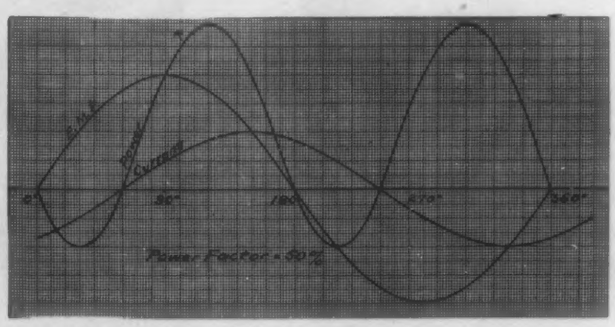


Fig 6.

circuit is equal to the product of the instantaneous value of the e.m.f, and the instantaneous values of the current.

The curve P represents these instantaneous values of the power. It will be noted that in the case of unity power factor (Fig. 5), the curve P is entirely above the axis, that is the line of zero value; this indicates that the power is all flowing in one direction. It will also be noted that the maximum value of the e. m. f. occurs at the same instant as the maximum current, which condition gives the maximum value of the power for these values of the current and the e.m.f., as can be seen from the figure.

Referring to Fig. 6, it will be noted that for a power factor of 50 per cent, part of the curve, P, is below the axis, which indicates that the power is not all flowing in the same direction, but that during a part of the cycle a portion of the power is actually being "pumped back" into the circuit. The net value of the power supplied is equal to the difference between that represented by the area enclosed by the curve, P, which is above the axis and the area enclosed by that part of the curve which is below the axis.

Assuming a sine wave of e. m. f., and of current (modern commercial alternating current generators give waves closely approximating a sine wave), and denoting the maximum value of the e.m.f. by **E**, the maximum value of the current by **I**, and the instantaneous value of the e.m.f. by e, we have

$$e = \mathbf{E} \sin \phi,$$

where $\phi = \omega t$, in which $\omega = 2\pi f$ (f being the frequency of the circuit in cycles per second) and t = the time in seconds measured from the instant when the e.m.f. crosses the axis in a positive or rising direction.

The instantaneous value of the current, $i = \mathbf{I} \sin (\phi - \theta)$, where θ = the angle of phase displacement between the current and the e. m. f. The instantaneous power, p, is equal to the product of the instantaneous e. m. f. and the instantaneous current, or

$$p = e\, i, = \mathbf{E} \sin \phi\ \mathbf{I} \sin (\phi - \theta)$$

$$\text{or } p = \mathbf{EI} \cos \theta \sin^2 \phi - \mathbf{EI} \sin \theta \sin \phi \cos \phi.$$

Let P = the average value of p,

then P = av'g $\mathbf{EI} \cos \theta \sin^2 \phi - \mathbf{EI} \sin \theta \sin \phi \cos \phi$)

$$= \mathbf{EI} \cos \theta \text{ (av'g } \sin^2 \phi) \ \mathbf{EI} \text{ sin av'g (sin } \phi \cos \phi).$$

The average value of $\sin \phi = \frac{1}{2}$, and the average value of $\sin \phi \cos \phi = 0$, substituting these average values in the above equation, we have

$$P = \frac{\mathbf{EI} \cos \theta}{2}$$

But **E**, the maximum value of the e.m.f. wave $= \sqrt{2}\, E$, where E is the effective value of the e.m.f. Also, if I denotes the effective current, the maximum current, $\mathbf{I} = \sqrt{2}\, I$. Therefore, we have the fundamental formula:

$P = EI \cos \theta$; the $\cos \theta$ being the power factor of the circuit.

If the power factor is unity, then $\cos \theta = 1$, and hence the above equation becomes $P = EI$, which, as will be noted, is the same as for direct current. The power factor is very seldom as high as unity, and it is therefore almost always necessary to use a wattmeter rather than a voltmeter and ammeter; a properly constructed and accurately calibrated wattmeter will measure power correctly regardless of the value of the power factor. The power factor of a single phase alternating current can be easily obtained by taking the product of the volts and the amperes as indicated by a voltmeter and ammeter and dividing this result into the actual power reading as indicated by a wattmeter.

The actuating force in an indicating wattmeter is derived from two sets of coils, one being connected in multiple, and the other in series (as in the case of the watt-hour meter) with the load to be measured. The reaction between these two coils is at each instant proportional to the instantaneous values of the current and the e. m. f., so that the total deflecting force acting on the pointer of the instrument is at all times proportional to the true power.

A two-phase system (often called "quarter phase"), can be considered as two single phase systems, and the power being supplied by such a system is simply the sum of the power flowing in the two equivalent single-phase systems, and can be measured by a single-phase wattmeter in each system, or by one polyphase wattmeter as shown in Fig. 7, in which

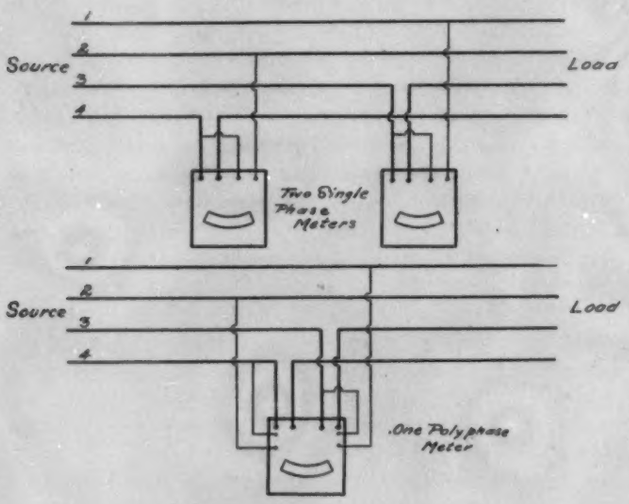


Fig. 7.

lines 1 and 3 constitute one-phase and 2 and 4 the other phase.

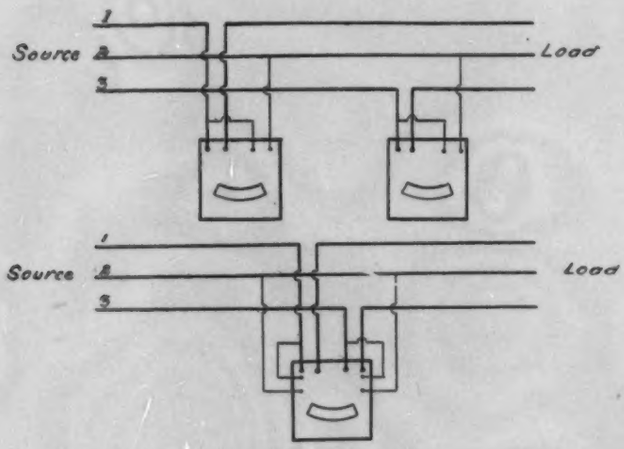


Fig. 8.

The power in a two-phase three-wire system can also be measured by two single-phase wattmeters or by one polyphase wattmeter, the connections being made as shown in Fig. 8, in which line number 2 carries the resultant current. Fig. 9 shows the connections used when measuring power in a balanced two-phase three-wire system with one single-phase meter. In this case the voltage impressed on the meter will be $\sqrt{2}$ or 1.41 times the voltage of either phase, and when the system is balanced the current flowing in the line, 2, will also be $\sqrt{2}$, or 1.41 times the current

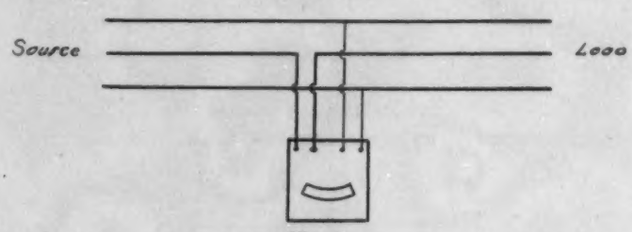


Fig. 9.

in either phase. The one wattmeter method will measure the true power only when the phases are perfectly balanced, and is therefore very seldom used.

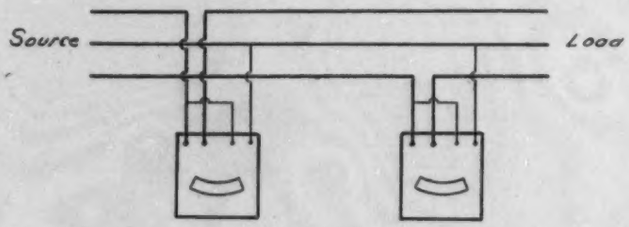


Fig. 10.

The power flowing in a three-phase system can be measured by two single-phase meters connected as shown in Fig. 10, or by one polyphase meter connected as shown in Fig. 11.

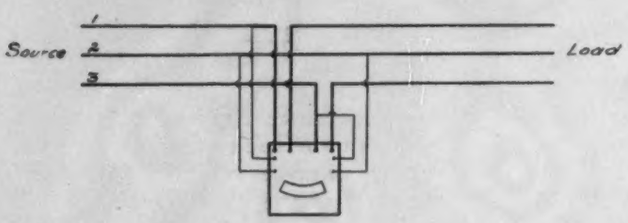


Fig. 11.

The power in a three-phase four-wire system can be measured by three single-phase wattmeters connected as shown in Fig. 12; the three-phase four-wire system being virtually three single-phase systems. The

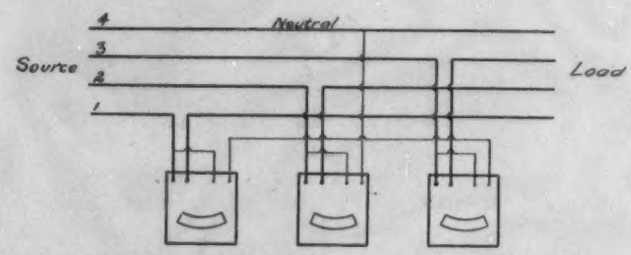


Fig. 12.

total power will be the sum of the indications of the three meters. The power in a three-phase four-wire system can also be measured by two single-phase meters connected as shown at (a) in Fig. 13, or with

one polyphase meter in conjunction with current (or series) transformers connected as shown at (b) in Fig. 13.

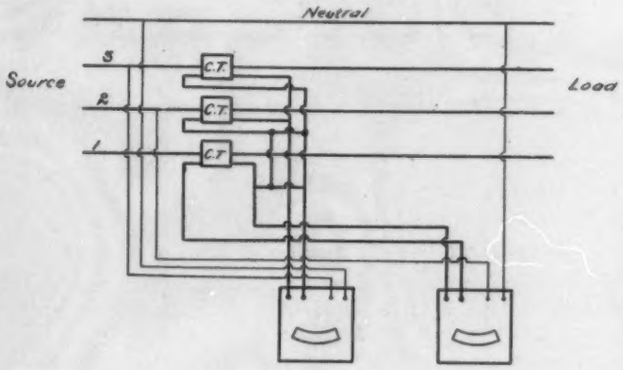


Fig. 13a.

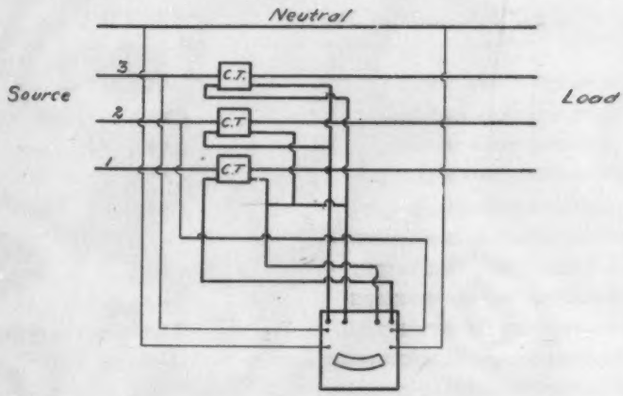


Fig. 13b.

The power flowing in a three-phase system is expressed by the equation, $P = \sqrt{3}\ EI, \cos\theta$, where E is the voltage between the phases, I the current per leg and cos θ, the power factor of the circuit, When the system is not balanced the average values of the current, the voltage and the power factor should be used in the above equation, remembering that θ is the angular displacement between the line current and the voltage between line and neutral.

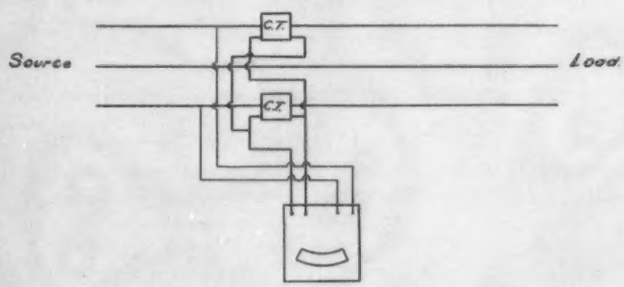


Fig. 14.

Fig. 14 shows the method of connecting one single-phase wattmeter for measuring the power in a balanced three-phase three-wire system.

Power is the rate at which energy is supplied. Electrical power is measured in watts and kilowatts, and electrical energy is measured in watt-hours and kilowatt-hours. "Purchasers of power" are in reality purchasers of energy, and in order to determine the energy flowing in a circuit it is necessary that the power be multiplied by the time. If w = the power in kilowatts, and t = the time in hours during which the power is flowing, then the energy = w t = kilowatt-hours. Since it is energy and not power which is bought, it is necessary to have an instrument which will take into consideration the time element; such an instrument is the watthour meter.

(TO BE CONTINUED.)

MUKDEN ELECTRIC-LIGHT PLANT.

Vice-Consul-General F. D. Cloud furnishes the following information concerning the electric lighting of Mukden. The Mukden electric-light plant was installed by the Chinese local government in connection with the government's provincial mint on Oct. 1, 1909. According to the original plans the plant was to have been of only 5000 lamps capacity. Recently, however, the management decided to enlarge the plant of 15,000 lamps, and has already placed orders for the additional machinery and materials. The total cost of the plant when completed will be approximately $165,000 American currency, of which amount an American firm will supply about $115,000 worth of materials and machinery. The entire installation has been under the supervision of an American engineer employed by the Chinese Government.

The plant is affording a most satisfactory service and, for this part of the world, at very reasonable rates. The popularity of electricity among the Chinese as a means of lighting has again been fully demonstrated by the eagerness with which the inhabitants of Mukden are clamoring for lights.

The following is a schedule of the new concern's lighting rates—flat-rate system—per month: Carbon filament lamps: eight candlepower, 54 cents; 16 candlepower, 90 cents. Metallic filament lamps: 20 candlepower, 90 cents; 30 candlepower, $1.34; 50 candlepower, $1.80; 80 candlepower, $2.24. Lamps will be paid for and owned by the customers. Wiring and pendant fittings will be installed for 23 cents each.

Meter-rate system: Per kilowatt-hour (1000 watts for a period of one hour), 11 cents; meter rental, on bills less than $9, 45 cents per month. Ten lamps or more will be required for each meter. Wiring and fittings will be installed at cost price, and the material will be the property of the customers. The installation cost per pendant lamp will be from $1.35 to $2.25 each, varying as the distance between lamps increases and the number of lamps decreases.

Discount on bills per month: Five per cent during the first five days of succeeding months; five per cent on all bills over $22; 10 per cent on all bills over $45; 15 per cent on all bills over $67.

Safety Appliances for Electrical Workers was the subject of an address by Dr. William H. Tolman, director of the Museum of Safety and Sanitation of New York, in the Western Society of Engineers' rooms, Chicago, February 14th. Dr. Tolman has returned recently from a visit to the museums of safety of Budapest, Paris, Munich, Berlin and Vienna, and discussed both foreign and domestic safety precautions. Incidentally, he mentioned the importance of protecting electrical workers called upon to handle charged conductors and "dead" conductors that may become "alive."

REPORT UPON PACIFIC T. & T. CO.

BY C. L. CORY.

To the Honorables, The Mayor and The Board of Supervisors, of the City and County of San Francisco, San Francisco, Californai.

Gentlemen:—In compliance with your resolution No. 4100 (New Series) dated June 30, 1909, I have made a personal inspection and examination of the complete equipment of The Pacific Telephone and Telegraph Company in San Francisco, including its books, records, engineering data, etc., and beg herewith to submit the following:

REPORT.

The information required by your resolution is included under three headings, as follows:

I. The true valuation of the entire installation of The Pacific Telephone and Telegraph Company in San Francisco on July 1st, 1909, and also all additional investments which properly belong to extensions and additions to the system in San Francisco during the period from July 1st, 1909, to January 1st, 1910.

II. The average number of telephones operated by the company in San Francisco for each month of the year 1909, the additional telephones installed during each month of the year, and the average revenue to the company per telephone.

III. The total annual revenue and expenses of The Pacific Telephone and Telegraph Company in San Francisco for the year 1909, including a proper segregation of accounts showing separately the revenue from local and long distance service, and the expenses of operation, maintenance, repairs, instrument rental, etc.

I.

Valuation of Plant.

In determining the valuation of the plant of the company on January 1, 1910, the complete inventory of the general plant on July 1, 1908, of The Pacific Telephone & Telegraph Company actually required and used in its San Francisco business as set forth in summary on page 6 of the printed report submitted by me on February 9, 1909, to the Mayor and Board of Supervisors of the City and County of San Francisco,[1] has been used as a basis. Reference to this report shows that the inventory as of July 1, 1908, was made jointly by representatives of the company and myself and these inventories were compiled in forms which were checked and verified by me.

On page 6 of the above mentioned report the additions to the plant of the company from July 1, 1908, to January 1, 1909, are also given in detail, as well as the valuation of the plant on January 1, 1909, which is copied below from the above mentioned report. The total investment represented in the various portions of the plant on January 1, 1910, also on July 1, 1909, and the increase in investment during the first six months and also the last six months of 1909, are given below.

EXCHANGE PLANT, SAN FRANCISCO, CALIFORNIA.

	Valuation Jan. 1, 1909.	Valuation July 1, 1909.	Valuation July 1, 1910.
Real estate	$ 929,479.12	$ 985,619.71	$ 966,462.61
Exchange—Pole lines	285,461.53	317,399.95	318,718.28
" —Right of way	37,877.30	40,809.56	42,444.29
" —Aerial cable	348,371.00	475,610.57	496,604.42
" —Aerial wire	285,963.75	320,556.15	291,600.78
" —Underground conduit	1,244,246.04	1,276,054.61	1,311,616.69
" —Underground cable	1,432,760.13	1,518,258.21	1,558,853.27
" —Central office equipment	1,111,780.58	1,251,573.85	1,384,397.88
" —Subscribers' stat. equip	883,985.57	1,030,081.30	1,177,973.10
Construction in process	15,089.99	70,929.30	70,017.92
Furniture and fixtures	22,623.96	33,253.47	44,453.10
Tools and teams	48,650.79	50,476.37	52,777.82
Supplies	121,981.06	102,477.27	155,433.11
	$6,768,270.82	$7,446,100.32	$7,871,353.27

[1]See Journal of Electricity, Power and Gas, Mar. 13, 1909, for previous reports.

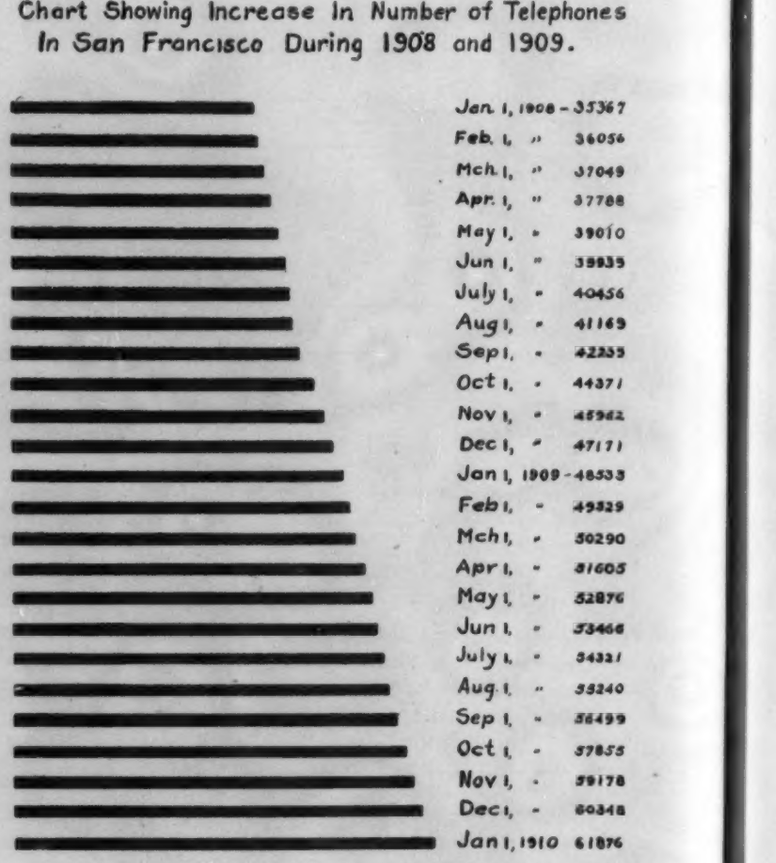
The following summary gives the total investment in, or valuation of, the plant in San Francisco on January 1, 1909; July 1, 1909; January 1, 1910; and also all additional investments belonging to extensions and additions to the system for the six months from January 1, 1909, to July 1, 1909; from July 1, 1909, to January 1, 1910; and also for the full year 1909:

Valuation of plant January 1, 1909	$6,768,270.82
Valuation of plant July 1, 1909	7,446,100.32
Valuation of plant January 1, 1910	7,871,353.27
Additions to plant January 1 to July 1, 1910	677,829.50
Additions to plant July 1, 1909, to January 1, 1910	425,252.95
Additions to plant for the entire year 1909	1,103,082.45

II.

Number of Telephone Stations and Average Revenue.

The number of telephones installed and in operation January 1, 1909, as given on page 6 of my previous report was 48,533. The number of telephones installed and in operation on January 1, 1910, the number connected, disconnected,



and the net gain for each month during the year 1909, and also the number of telephones in operation on the first of each month of 1909 are given below:

	Connected.	Disconnected.	Net Gain.	1st of Mo.
January	1284	488	796	*48,533
February	1576	615	961	49,329
March	2295	980	1315	50,290
April	2036	765	1271	51,605
May	1703	1113	590	52,876
June	2014	1159	855	53,466
July	1800	881	919	54,321
August	2423	1164	1259	55,240
September	2491	1235	1356	56,499
October	2213	890	1323	57,855
November	2122	952	1170	59,178
December	2634	1106	1528	60,348
	24,691	11,348	13,343	
Total stations January 1, 1910				**61,876

*Including 508 Private Branch Switchboard Stations.
**Including 654 Private Branch Switchboard Stations.

From these figures it will be seen that the net gain in telephones in operation for the year 1909 was 13,342, which is a gain of 27.5% over the number in operation on January 1, 1909. The corresponding increase for the previous year, 1908, was 13,166 telephones, which was a gain of 37.2% over the number in operation on January 1, 1908.

The number of telephones in operation on the first of each month, beginning January 1st, 1908, and ending January 1, 1910, is represented graphically by the accompanying chart.

The average revenue per telephone for each month during the year 1909, and also the average revenue per telephone for the first six months and for the last six months during 1909 is shown in the following statement.

MONTHLY STATEMENT OF STATIONS IN SAN FRANCISCO FOR 1909.

Month.	Number on 1st.	Net gain during Month.	Average for Month.	Revenue from Stations.	Ave. rev. per Station.
January	48,533	796	48,931	$185,092.48	$3,783
February	49,329	961	49,809	176,203.80	3.537
March	50,290	1315	50,948	191,201.53	3.753
April	51,605	1271	52,240	196,250.65	3.757
May	52,876	590	53,171	194,213.05	3.653
June	53,466	855	53,993	197,089.75	3,650
July	54,321	919	54,781	190,171.33	3,471
August	55,240	1259	55,870	196,225.32	3.512
September	56,855	1356	57,177	198,575.78	3.473
October	57,855	1323	58,516	208,831.04	3.569
November	57,178	1170	59,763	209,074.85	3.498
December	60,348	1528	61,112	209,593.31	3,430

Average revenue per station, Jan. 1 to June 30, 1909.....$3,689
Average revenue per station, July 1 to Dec. 31, 1909..... 3,492

The average revenue per station as given is obtained by dividing the total revenue from local telephone service for each month of the year by the average number of telephone stations, including extensions, private branch exchange stations, dead-head telephones, etc.

The average revenue per station from January 1 to June 30 and from July 1 to December 31 for 1908, and also for 1909, is as follows:

1908—January 1 to June 30 .....$4.233
" —July 1 to December 31 ..... 3.714
1909—January 1 to June 30 ..... 3.689
" —July 1 to December 31 ..... 3.492

The reduction of the average revenue per station from $4.233 for the first six months of 1908 to $3.714 for the last six months of 1908 is due in part to the reduction in rates which took effect on July 1, 1908, and also partly due to the increase in the number of telephones in operation during the last six months of the year as compared with the number of telephones during the first six months of the year. On the other hand the reduction in the average revenue per station from $3.714 from July 1st to December 31, 1908, to $3.689 during the period from January 1st to June 30, 1909, is due solely to the increase of the number of telephones in operation. Similarly, the reduction in the average revenue from $3.689 for the first six months of 1909 to $3.492 for the last six months of the same year is due both to the reduction in rates taking effect July 1, 1909, and to the increase in the number of telephones in operation during the last six months of the year as compared with those in operation during the first six months of the year.

The average revenue per station for the different classes of service during December, 1907, 1908 and 1909 is given below, showing the effect of the reduced rates which began July 1, 1908, the rates being still further reduced, beginning with July 1, 1909.

	1907.	December 1908.	1909.
Business Measured.			
Number of stations	1,989	2,702	3,452
Total revenue	$26,240.02	$32,936.26	$35,017.48
Average revenue per station	$13.19	$12.19	$10.14
Business Prepayment. (Nickel in Slot.)			
Number of stations	7,716	9,690	9,916
Total revenue	$48,847.50	$58,933.05	$56,551.82
Average revenue per station	$6.33	$6.08	$5.70
Residence Unlimited.			
Number of stations	5,823	8,010	7,262
Total revenue	$22,107.50	$24,829.15	$23,238.55
Average revenue per station	$3.80	$3.10	$3.20
Residence Measured.			
Number of stations	(None)	447	3,032
Total revenue		$ 1,309.15	$ 8,800.98
Average revenue per station		$2.93	$2.90
Residence Prepayment.			
Number of stations	7,427	9,219	13,301
Total revenue	$12,537.10	$16,302.25	$23,321.82
Average revenue per station	$1.69	$1.77	$1.77
Private Branch Exchange.			
Number of stations	7,778	11,398	16,228
Total revenue	$25,330.56	$30,136.30	$41,079.87
Average revenue per station	$3.25	$2.64	$2,53
Extensions.			
Number of stations	3,280	5,604	5,433
Total revenue	$ 3,268.65	$ 2,811.50	$ 2,742.73
Average revenue per station	$1.00	$0.50	$0.50
Miscellaneous.			
Number of stations	491	675	1,642
Total revenue	$ 5,819.36	$ 6,337.19	$ 6,135.40
Average revenue per station	$11.85	$9.39	$3.74

III.

Cost of Operation.

Following the classification used by the company at the present time in keeping their accounts, the statement of earnings and expenses for the year 1909 is segregated as follows:

Revenue.	6 months ending June 30, 1909.	6 months ending Dec. 31, 1909.	Totals Year 1909.
Local	$1,140.051.26	$1,212,471.63	$2,352,522.89
Private line	13,341.90	6,596.86	19,938.76
Long distance	36,180.16	39,535.15	75,715.31
Total	$1,189,573.32	$1,258,603.64	$2,448,176.96
Expenses.			
General	$ 42,922.39	$ 51,447.86	$ 94,370.25
Operating	314,348.60	373,773.25	688,121.85
Maintenance—Repairs	163,691.66	167,357.74	331,049.40
" —Removing.	99,893.40	111,397.84	211,291.24
" —Depreciatn	147,648.23	160,498.30	308,146.53
Instrument rental	52,195.31	55,134.56	107,329.87
Conduit, pole & roof rent	392.41	627.39	1,019.80
Insurance—Per. property	7,764.62	6,735.44	14,500.06
" —Real estate	2.382.99	2,000.15	4,383.14
Taxes—Per. property	28,898.02	31,492.38	60,390.40
" —Real estate	3,723.86	4,734.27	8,458.13
Total	$ 863,861.49	$ 965,199.18	$1,829,060.67
Net Revenue	$ 325,711.83	$ 293,404.46	$ 619,116.29

An analysis of the above statement of expenses is in conformity with the segregation of accounts which is outlined in my previous report filed with the Clerk of the Board of Supervisors on February 9, 1909, as set forth on pages 9, 10 ond 11 of said report. Certain minor changes have been made during the past year in a few of the sub-headings, but these minor changes are unimportant, and conform in practically every detail with the recommendation made by me regarding the form of statement, etc., in the former report above referred to. The gross revenue, expenses and net revenue of the company for both 1908 and 1909 are given below:

1908—Gross revenue $2,150,734.09
" —Expenses 1,603,552.06
" —Net revenue .....$ 547,182.03
1909—Gross revenue $2,448,176.96
" —Expenses 1,829,060.67
" —Net revenue .....$ 619,176.29

The Pacific Telephone & Telegraph Company have since July 1, 1908, kept a separate and complete set of books to separately cover the accounts for San Francisco. As a result the work of segregation of accounts, both as regards new construction and gross revenue, expenses and net revenue, has been readily and accurately done.

In conclusion, I am glad to acknowledge the many courtesies extended to me by the officials of the company in connection with the preparation of this report. Data and information which I have requested have been given me in great detail, and the officials of the company with whom I have worked have offered me every facility possible.

STEAM

RAPID INSTALLATION OF A STEAM TURBINE AT OAKLAND.

BY F. H. VARNEY.[1]

On the 6th of July, 1908, the management of the Pacific Gas and Electric Company requested that the matter of a 9000 k. w. turbine installation in Oakland be given consideration and attention. The choice of a prime mover rested between two types of turbine—the horizontal and the vertical. After the question of prompt delivery and the relative merits of both types had been fully considered, the Curtis vertical turbine, built by the General Electric Company, was chosen.

This decision was reached about the middle of July, and orders were received to have the plant in operation for the Christmas load. The engineering department, therefore, had to undertake to design, construct, and place in operation a complete turbine plant in one hundred and sixty-two days.

It is hard for those whose avocations lie in fields other than technical to appreciate the immense amount of detail involved in an engineering problem of this nature. Preliminary surveys must be made; preliminary plans drawn and submitted for approval. Then come the working drawings. These in turn must be examined, and any changes made before it is too late. For it must be remembered that once the engineer's thoughts have been translated into concrete, iron, and steel they can not be revoked at any future session; his work must stand as a monument to either his ability or his incompetency.

All branches of the department were now actively engaged in preparing their particular portions of the work. The preliminary labor had been completed and approved; the finishing touches were being given to the working drawings; specifications were drawn up, and many a tiny lamp was burned long into the small hours of the morning because of an earnest endeavor that no detail should be overlooked. In due time all the plans and specifications were completed and approved, and the contracts were awarded and signed. Some of the contractors, who were never known to make deliveries in less than nine months, fairly gasped when they were informed what was required of them. But on account of the heavy bonus and the penalty attached to each contract, they determined to strain every effort to complete the contracts on time.

The engineer can not lose sight of certain given factors, and while promises are made in perfectly good faith, their fulfillment may be indefinitely deferred on account of apparently insurmountable obstacles. An engineer in charge of work must be everywhere; must anticipate delays, and be ready to step instantly into the breach with a solution; he must have an accurate knowledge of human nature, and be able to swing troublesome contractors into line; he must be, in truth, the coacher of the team. It is gratifying to know that with our organization, the personnel of those in charge, both in the office and in the field, and the esprit de corps, which makes possible the existence of that great fundamental principle of success—team work—we were able to complete the turbine installation (from the first day of breaking ground to the time of actually operating the turbine under its own steam) in seven days less time than that set by the management.

While avoiding a purely technical discussion of the installation, it will be a matter of general interest more clearly to understand the many elements that are necessary to produce the salable product, electric energy.

Did you ever stop to consider what a mysterious and intensely interesting product it is? Unlike that of any other manufacturing concern, none of the employees has ever seen the product, yet it is handled in quantities large and small, and upon receipt of an order from a customer it can instantly be sent to him—by wire. The manufacturer of some powerful locomotive could take you to his factory and trace the development of his product from the raw material to the high-speed express engine. The manufacturers of electricity can show you neither the raw material nor the finished product. But we can take you to some rocky point overlooking one of the great reservoirs in the mountains and tell you that there are untold quantities of our product under the shimmering surface of the water. Or, standing in front of this great steam turbine in Oakland, we could tell you that our product is being manufactured at the rate of more than two hundred thousand units daily.

The turbine plant in Oakland, known as Station C, is situated on a part of the property of the Oakland Gas Light and Heat Company, a subsidiary company to the Pacific Gas and Electric Company. The property is bounded by First street, Grove street, Jefferson street, and the Oakland estuary. The steam turbine is the largest single-driven unit on the Pacific Coast. It occupies about one-tenth of the space required for a corresponding reciprocating engine plant of the same capacity. The advantages of this type of prime mover over the reciprocating engine are numerous. An interesting incident occurred in this relation worthy of comment. One of the problems that the operating engineer has to contend with in the use of the reciprocating engine is in jacking over the engine by hand, when it is necessary to do any overhauling work. The matter of providing the turbine with similar apparatus for turning it through part of a revolution caused us considerable thought, but one day, during the assembling of the turbine, we were surprised to see one of the erecting men climb into the ventilator flue at the top of the turbine and revolve the turbine with one hand. Some idea of the perfect balance of the turbine may be gained when it is stated that the revolving parts weigh seventy-two tons. Another interesting feature is that this entire weight is carried on a thin film of oil which is forced into the step bearing under a pressure of more than half a ton to the square inch.

The condenser, shown to the left of the turbine, is larger than the turbine itself, and if the tubes were withdrawn and placed end to end, they would extend for a distance of sixteen miles. A story is told of a

[1]The Pacific Gas and Electric Company's Engineer of Operation and Maintenance of Steam and Gas Engineering.

certain marine engineer. Upon his first visit to the station and first view of the condenser, he expressed his admiration for it, but was in doubt as to the use of the "small vertical thing" at the side of the condenser. This "small vertical thing," however, is capable of developing 12,000 h. p.

One of the greatest sources of worry to the engineer of the condensing plant is circulating water. "Losing the water," as it is termed, is a very serious matter, but owing to the precautions which have been taken at Station C this danger is far removed. A 42-in. pipe has been laid to the pier-head line in the Oakland estuary, and at the time of the lowest tide there is a trifle more than 6 ft. of water over the intake. By keeping the mud dredged away from the pump suction an ample supply of circulating water is assured.

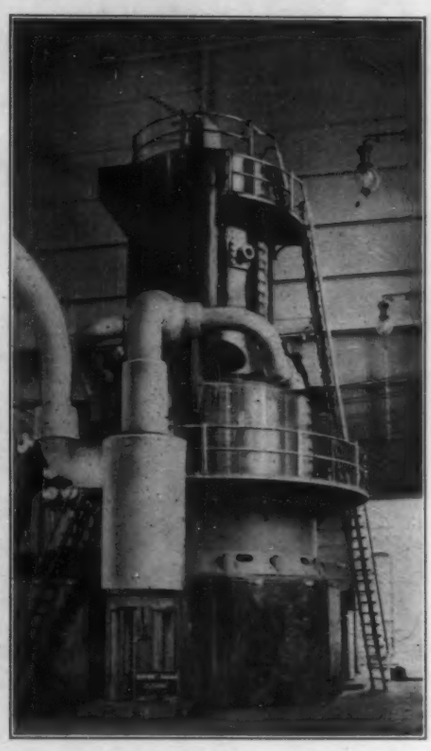
This sturdy unit of 12,000 h. p. is served by eight water-tube safety boilers, with superheaters, installed in batteries of two, and four in a row facing each other, as will be noted in the illustration. Two sheet steel stacks, well guyed, rise to a height of one hundred and ten feet above the boiler-room floor, with ample capacity for four boilers each. The Hammel type of furnaces with return flame oil-burners are used throughout.

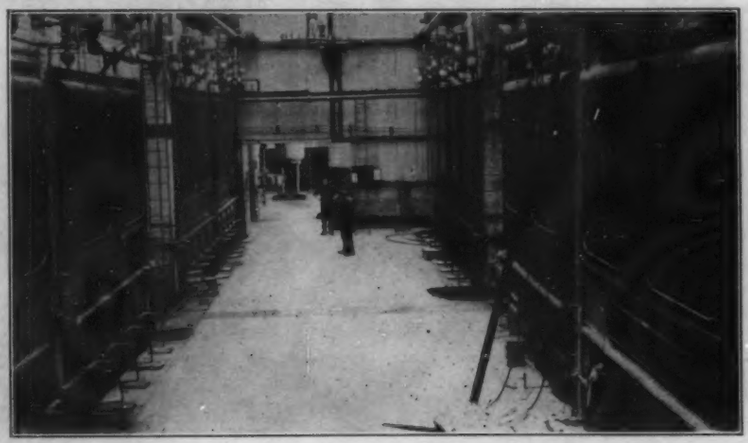
The visitor at Station C is impressed with the compactness of the installation. The turbine and its auxiliary apparatus is accessible at all points, yet the amount of waste room has been reduced to a negligible quantity.

Station C is entirely a generating station. The distribution station, with the necessary switchboards and high-tension switches, is an entirely separate building, known as Station A. The transmission station will adjoin it, and will be known as Station B, thus giving in Oakland three distinct types of stations: generating, distributing, and transmitting.

STATION C, OAKLAND

Showing Exterior, Station During Construction, 9,000 k.w. Curtis Turbine and Boiler Room.





THE LOW PRESSURE STEAM TURBINE.

Discussion by members of the San Francisco Section, A. I. E. E., January 28, 1910, of paper by E. O. Shreve, as published in this journal, February 19, 1910. The paper was followed by lantern slide talks by F. E. Vickers and K. G. Dunn. The following participated in the discussion:

C. W. Burkett, General Superintendent of Plant, Pacific T. & T. Co., San Francisco, Chairman.

A. J. Bowie, Jr., Electrical Engineer, San Francisco.

E. O. Shreve, Sales Engineer, General Electric Co., San Francisco.

K. G. Dunn, Vice-President, Hunt, Mirk & Co., San Francisco.

F. E. Vickers, Assistant Engineer, General Electric Co., San Francisco.

C. L. Cory, Professor of Electrical Engineering, University of California.

A. J. Bowie, Jr.: I would like to ask Mr. Shreve if there is any material gain in the economy of the low pressure turbine in super-heating?

E. O. Shreve: I think there is very little gained in that respect. If you take steam at 150 pounds pressure and reduce it through a reducing valve to atmospheric pressure to introduce into the turbine, you secure in the neighborhood of 100 degrees super-heat, which would give about 8% increase in economy on the turbine, this being more than offset by the loss due to decreased steam pressure. This is not exactly the case with the Curtis type of machine because both low pressure and live steam can be and are brought directly in contact with the revolving element. The low pressure steam being expanded through one set of nozzles and the high pressure through another. The increased velocity obtained by using high pressure steam in this manner will give a decrease in water rates of from 20 to 30%. This also allows non-condensing operation.

A. J. Bowie, Jr.: Taking the live steam direct, without counting with low pressure steam at all—is that what you mean? To turn a certain amount of live steam in the low pressure, not super-heating the low pressure steam.

E. O. Shreve: No; there is no added gain there. You are thinking of the feasibility or advisability of using live steam to get increased economy from the low pressure, it would be better to use the live steam in a high pressure turbine. The only reason we use high pressure steam at all is in case of over loads where we have insufficient exhaust steam, or in case of the necessity of shutting down the engine or other source from which the exhaust steam is obtained. Ordinarily it would not be good practice to put in a low pressure machine that would take a great deal of live steam. I would like to emphasize the fact that in the case of the installation of the Interborough Rapid Transit, that this gain was made without an increase in the boiler plant or the building at all, and with about half the total expenditure for the machinery installed that it would take for the original machinery, including boilers and the total installation.

E. O. Shreve: We have another installation at the E. K. Wood Lumber Company, in Bellingham, Washington, which would probably interest the local people, a 400 kw. mixed pressure machine, which takes exhaust steam from an engine carrying a variable load of about 300 h. p. to 750 h.p. The mixed pressure turbine is delivering power to a railroad and has a variable load of from 100 to 500 kw. This is a case with a variable load factor at both ends, and we have been able to get exceedingly satisfactory results from this installation. By installing the low pressure turbine in this particular instance they saved on their assumed cost of increase in capacity $10,000 approximately, and about 30% increase in efficiency. Besides that they have an additional advantage in this particular case, of using the condensing water to take away their refuse saw-dust and shavings. This turbine is designed to carry full load on either exhaust or live steam or both, and will deliver a large percentage of its rated capacity when operating non-condensing.

K. G. Dunn: On that question, steam expanding without doing work super-heats. Expanding from 150 pounds to what is used in the turbine would super-heat 60 to 70 degrees. This, alone, would give an increased economy of say 6 or 7 per cent. This would amount on a turbine over what we would get using saturated exhaust steam to 8 or possibly 9 per cent, due to the entrainment of the moisture in the exhaust steam.

With the admission valve as shown on the Westinghouse exhaust turbine full load could be carried with this admission valve admitting live steam. The governor would automatically open and allow the necessary pressure to be built up, when the supply of exhaust steam was insufficient. In fact the pressure would build up sufficient so that the machine could be operated non-condensing and carry full load. Under emergency conditions this feature is of great value in the plant.

I would like to take exception to a remark Mr. Shreve made in the early part of his paper, in which he stated that a 22 and 44 x 42 engine, 150 pounds, and 26 inches vacuum would rate at 1250 kw. The economy was 23 pounds per i.h.p. condensing, and 35 non-condensing. I think any Corliss engine man that you would talk to about a compound engine at 23 pounds per i.h.p. condensing would think it was a bum engine. He would realize that about 27 to 30 pounds mean effective pressure referred to the low pressure cylinder would be the most economical point. If Mr. Shreve will point out an example where they make large gains by combining an exhaust turbine with a conservatively rated engine, I would not take exception to it, but the mean effective pressure of this engine referred to the low pressure cylinder, to produce the rating given is over 50 pounds. He might just as well have taken a simple engine in which he would get about those results and be done with it, instead of tryingg to compare it with what we might say was a high grade engine. That is not a typical result, and the saving in fuel could not be produced with a high grade compound engine, operating at or about its economical rating.

E. O. Shreve: I wish to correct an apparent misunderstanding there. The water rate referred to 23 and 35 pounds condensing and non-condensing respectively, and were taken from actual tests. It is but one of many such instances where gains of this amount have been made.

K. G. Dunn: Even on that basis you would have over 50 pounds mean effective pressure referred to the low pressure cylinder when operating condensing. A conservative rating would not exceed 30 pounds, so you see the engine would be heavily overloaded, when delivering 1200 kw,, and the water rates given could not be obtained at 1200 kw. load. A conservative rating on that engine would not exceed 750 kw., instead of 1200, and to produce the results shown the engine would cut off at about 90% stroke. This is simply a case of taking the engine water rate at over loads, and comparing with combined results at most favorable load, a disguise of the true gain.

Mr. Miller: The Salt Lake plant contains an old Corliss engine 30 by 60, 60 revolutions, and is rated about 1200, and by the addition of a low pressure turbine of 1000 kw. capacity the power of the installation is increased about 60 per cent on the same fuel consumption. The equipment consists of 4000 square feet surface condensing. The circulating pump is a rather interesting thing, and is driven with an Alberger turbine. The Alberger condenser turbine is a single stage affair, but uses the steam over again three or four times on account of the internal arrangement of the plating. This machine of course has a governer, on account of being connected—having a mixed pressure arrangement.

Question: In these increases in power and economy is any allowance made for the power and steam used for running the condensing apparatus?

F. E. Vickers: At the Interborough plant in New York, the 20% gain in station economy due to the installation of their 5000 kw. Curtis low pressure turbine was measured at the coal pile, and therefore includes all power required for auxiliaries

C. L. Cory: For the man who is responsible for the reliability of service, the addition of low pressure steam turbines to

existing engines is very much in his favor. We know how difficult it is to adapt many existing plants that may be operating in parallel to a load where the load factor is widely variable during the day; and from what has been told us this evening about the possibility of a mixed pressure turbine, it is quite evident that with reciprocating engines of high average economy it is possible with a combination engine and turbine plant to get very high economy, at the same time have a plant capable of great flexibility of operation. If for instance we take, not an inferior but a very good compound condensing reciprocating engine plant, and increase the capacity, possibly for peak load only, by adding low pressure turbines, we are not only not increasing (as has been said) the size of the plant with no addtional investment in boilers, and not increasing the fuel bill, but we are increasing the peak load capacity and if necessary we can use the turbine as a high pressure turbine, or as a low pressure turbine, or perhaps use it as a combination of the two. We are not only increasing the peak load capacity, but we are increasing the average economy of the plant throughout the twenty-four hours, perhaps above some of the comparative curves shown by Mr. Dunn. There is one thing that must not be forgotten which was brought out by Mr. Dunn's curves. A high vacuum is absolutely essential. I could not help but think that the question was rather pertinent this evening when it was asked whether these economies expressed in percentages were obtained after the cost of the production of vacuum had been included. The necessary high vacuum sometimes costs not only energy for operation, but may require additional investment for the supply of a sufficient amount of cold water.

K. G. Dunn: On the question of vacuum, we once received a letter asking about a steam turbine, and the party said he understood it took a whole river of water to condense the steam from a turbine. Now steam from a turbine has no more heat units in it for a given vacuum than steam from a steam engine. Therefore it takes no more water to condense steam at a given vacuum from a turbine than from an engine. Any high vacuum apparatus for a large sized installation favorably situated for circulating water will take in the neighborhood of 5 per cent of the total amount of steam generated. It is a very simple matter to calculate as to what that gain is. If you gain 5 per cent in fuel per increased inch of vacuum and your total amount of power to secure high vacuum is 5 per cent, it does not seem that the high vacuum apparatus is an expensive addition to the plant. In fact it is advisable to get as high a vacuum as you can. Some people are under a misapprehension as to the reason why it is advantageous to have high vacuum for a turbine. A good cross compound engine will expand down to the neighborhood of 5 or 6 pounds absolute. High vacuum does not allow of more expansions in the engine but simply lowers the back pressure, the number of expansions being fixed by the cut off and cylinder ratios. Now the turbine is capable of expanding down to the lowest limit, and therein lies the increased economy of the turbine. There is no question but what the economy of the steam engine from the ordinary boiler pressures to atmosphere is superior to the turbine from boiler pressures to atmosphere; and also there is no question but what the turbine is more economical from atmospheric pressure to any commercial vacuum.

I would like to pass a remark also to prevent a misconception of the economies shown in the combination of low pressure turbines and engines. Some might get the idea it would be a good proposition to buy new engines and put exhaust turbines on them. I doubt this very much, although there are some engineers who are really in favor of this proposition. But I think if you will figure out the first cost of the installation, the additional cost of operation necessary with such a combination; these additions being due to extra labor, extra repairs, lubricating oil and so forth; that you will find it is a dubious investment, and you would be better off to install a complete, straight expansion turbine plant instead of a new combination reciprocating engine and low pressure turbine plant, on account of the increased fixed charges.

PRACTICAL MECHANICS, PAPER NO. 9.

(Belting—continued).

In addition to the advantage belting affords in effecting power transmission through long distances (as compared with rolling friction) there is a gain in frictional resistance due to the belt surrounding a large part of the pulley. This results in a greater turning effort at the driven pulley than would be possible with the mere line contact of two discs rolling together; or, as is really done—the same power is transmitted with much less bearing friction. In the following mathematical development of the laws of belting—tensions, power transmitted, etc., this increase in efficiency will be shown.

For the purpose of our discussion let

T_1 = the tension on the tight side of an endless belt.

T_2 = the tension on the loose side of the belt.

a = the angle of contact of the belt on the pulley.

ϕ = the coefficient of friction between the belt and pulley.

F = the total frictional resistance—i. e., the value, at the pulley circumference of the maximum adhesion between the belt and pulley.

K = the force to be transmitted, which must obviously be less than F else there would be slipping of the belt.

p = maximum allowable belt tension per inch of width.

W = the belt width in inches.

Before proceeding further a word in explanation of this term coefficient of friction may help to fix it clearly in mind. Suppose a smooth block of wood to be lying on a smooth table. The weight of this block acts as a force pressing it vertically downward against the table. Now if a cord were attached to the block and a spring balance fastened to it a certain number of pounds pull applied to the balance would cause the block to begin to slide along the table. Suppose the block weighed 4 lbs. and that it required 1 lb. at the balance to draw the block along the table. The ratio of this force to the weight or ¼ would be the coefficient of friction for these surfaces. In the case of two bodies rolling together (see paper No. 7) the force P pressing the two axles together corresponds to the weight of the block in our illustration, while K, the force which drives the follower is comparable to the tension in the cord as measured by the spring balance. In belting the effect of this coefficient of friction is greatly increased over what it would be if the pressure between shafts were applied simply to a flat belt surface resting on a metal surface. This is due to the varying tension in the belt as it goes around the pulley from the loose to the tight side.

This relation between the contact friction and the belt tensions can be shown, by taking the summation of the effects for small portions of the circumference to be $\frac{T_1}{T_2} = e^{a\phi}$ (e here being the mathematical constant 2.71828 or base value of the Naperian logarithmic system).

This expression $e^{a\phi}$ need not be feared by those not familiar with the use of the calculus as it will be conveniently disposed of before we reach our practical working formulas.

Now $F = T_1 - T_2$, the difference in tension between the two sides of the belt, since this difference is due to the frictional resistance between the belt and pulley.

Now K, the force to be transmitted, being less than F may be called equal to CF, where C is a slip safety factor, i. e. C is the per cent of the total force necessary to slip the belt, which is used to transmit power.

Thus: $K = CF$

or $K = C\ (T_1 - T_2)$ since $F = T_1 - T_2$

$$= C\left(T_1 - \frac{T_1}{e^{a\phi}}\right)$$ substituting for T_2 its equivalent value from the equation $\frac{T_1}{T_2} = e^{a\phi}$

or $T_2 = \frac{T_1}{e^{a\phi}}$ This equation it will be seen gives the force transmitted, K, in terms of the belt tensions and frictional values.

In order to put our belting calculations to practical use they must be reduced to terms of horsepower, belt speed in feet per minute and belt widths in inches.

Now the horsepower transmitted by belting may be expressed thusly: H. P. $= \frac{V \times K}{33000}$ i. e. the velocity in feet per minute multiplied by the force transmitted, gives the foot lbs. of energy, which, divided by the number of foot lbs. per minute in a horsepower gives the number of horsepower.

Solving this algebraically for W gives

$$W = \frac{33000 \times \text{H. P.}}{V\,C\,p\left(1 - \frac{1}{e^{a\phi}}\right)}$$

For leather belts on iron pulleys the value of ϕ the coefficient of friction has been found by experiment to lie between .56 for dry surfaces and .15 for oily surfaces, average conditions giving from .25 to .30 h.p. Let us therefore take $\phi = .25$ as a conservative value. a, the angle of contact will be in cases of power transmission approximately 180°, i. e. the belt will cover one-half the pulley. A fair value for Cp is 55 for double leather belting. This

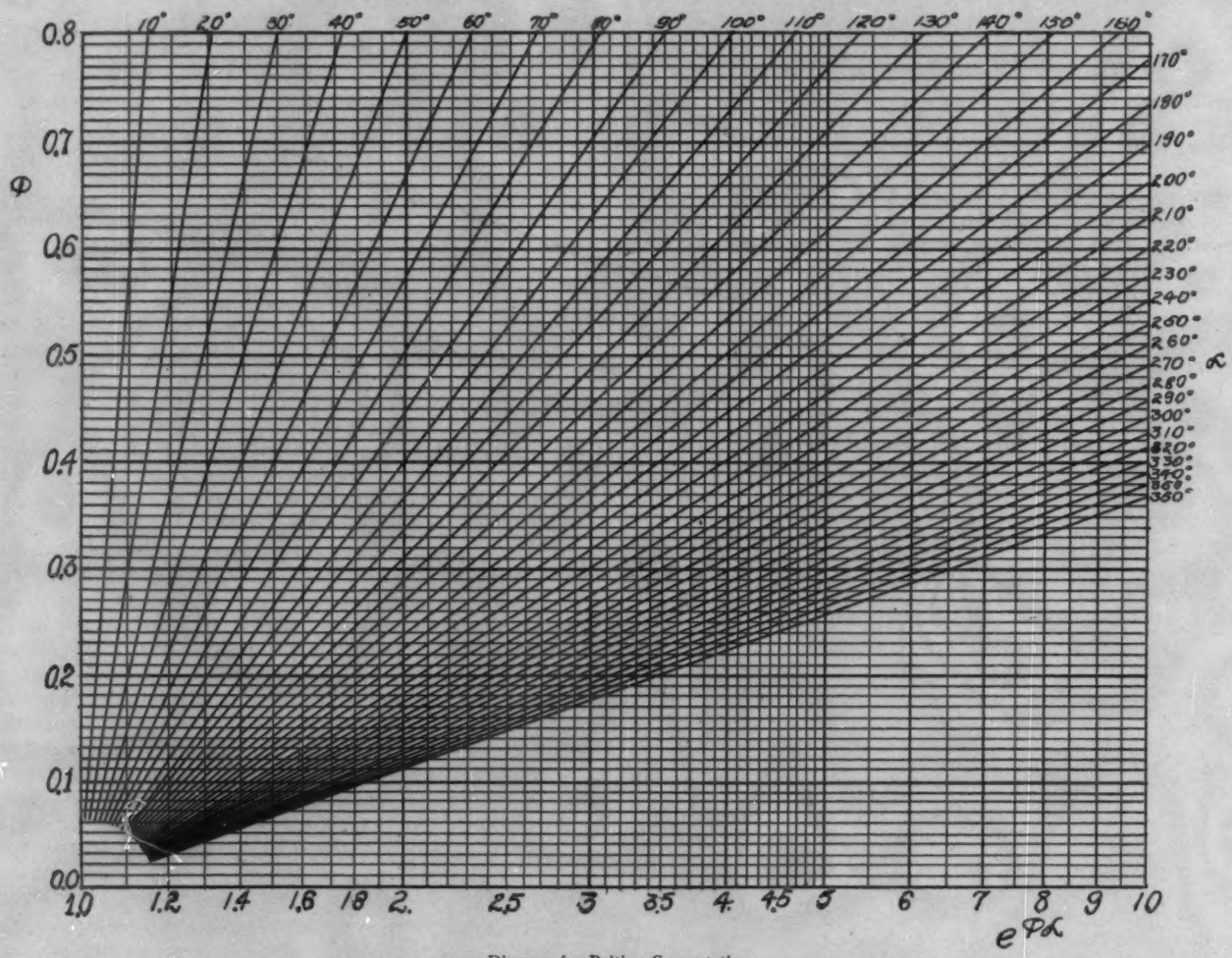


Diagram for Belting Computation.

But we have a value for K in an equation above. Substituting this gives

$$\text{H. P.} = \frac{V\,C\left(T_1 - \frac{T_1}{e^{a\phi}}\right)}{33000} = \frac{V\,C\,T_1\left(1 - \frac{1}{e^{a\phi}}\right)}{33000}$$

By inspecting this equation it will be noted that the horsepower and the velocity are variable terms while the remaining factors are all constant for a given belt and pulley.

Now if p = maximum allowable belt tension per inch of width then $p \times W = T_1$ the maximum tension for the whole belt width.

Putting therefore $p\,W$ for T_1 in the above question we have

$$\text{H. P.} = \frac{V\,C\,p\,W\left(1 - \frac{1}{e^{a\phi}}\right)}{33000}$$

constant includes the safety factors of both strength and slip, being the product of the maximum tension per inch width and the per cent of the actual force necessary to produce slipping.

Thus if 70 lbs. were the maximum allowable strain per inch of width then $C \times 70 = 56$ when C is taken as .80 or 80% of the force necessary to slip the belt.

We now have all factors in the above equation with the exception of $e^{a\phi}$.

In order to avoid the calculation involved in this term a diagram has been worked out by means of which the value of $e^{a\phi}$ may be easily and instantly found for any usual values of ϕ and a. This diagram may be found in Le Conte's "Mechanics of Machinery" and is here reproduced as it appears in that work. The ordinate values on the left are values of ϕ ranging as seen from 0 to .0. Values of a from 0 to 360° are drawn radiating from the lower left hand corner of the diagram while

the resultant values of $e^{a\phi}$ are drawn vertically as shown by the abscissae scale at the the bottom. To determine $e^{a\phi}$ for the above values $\phi = .25$ and $a = 180°$ start at the .25 line on the left and follow out till it intersects with the 180° line, then drop vertically to the bottom of the diagram where the value 2.20 will be found. In similar manner the value of $e^{a\phi}$ may be found for any usual values of the exponents.

We can now substitute the values in our last equation. Thus:

$$W = \frac{33000 \times \text{H. P.}}{V \times 56 \times \left(1 - \frac{1}{2.20}\right)}$$

which simplified gives

$$W = \frac{1060 \times \text{H. P.}}{V} \text{ or practically}$$

$$W = \frac{1000 \times \text{H. P.}}{V}$$

This will be recognized as the old belting rule: "A belt 1-in. wide travelling 1000 ft. per minute will transmit 1 h.p."

Thus it is found that by the use of the accompanying diagram the necessary belt width for transmitting any required horsepower at a desired belt velocity may be obtained. And this for any predetermined values of frictional coefficient and angle of contact. The working equation is best put into the form

$$W = \frac{33000 \times \text{H. P.}}{V \times C \times p \left(\frac{e^{a\phi} - 1}{e^{a\phi}}\right)}$$

Referring to paper No. 8 in the preceding issue it will be remembered that the relation

$$V = \frac{\text{r. p. m.} \times \pi D}{12}$$

was developed. By substituting from the value of

$$W = \frac{1000 \text{ H. P.}}{V}$$

we get the relation.

$$V = \frac{3800 \times \text{H. P.}}{D \times \text{r. p. m.}}$$

the belt velocity in terms of horsepower pulley diameter in inches and speed of the pulley.

Prof. Le Conte ingeniously shows the ratio gained by belting over friction gearing as follows:

Let P be the pull between the shafts.

$$P = T_1 + T_2; \text{ when } a = 180° \text{ then } P = T_2 + T_2 e^{a\phi}$$

$$= T_2\left(e^{a\phi} + 1\right) \text{ or } T_2 = \frac{P}{e^{\phi a} + 1.}$$

At point of slip $F = K = T_1 - T_2$ or $K = T_2 e^{\phi a} - T_2$

$$= T_2\left(e^{a\phi} - 1.\right)$$

$$\text{Hence } K = \frac{P\left(e^{a\phi} - 1\right)}{\left(e^{a\phi} + 1\right)}$$

Now if ϕ be taken as, say .28 from the diagram $e^{a\phi} = 2.41$

$$\text{or } K = P\left(\frac{2.41 - 1}{2.41 + 1}\right) = \frac{1.41}{3.41} P$$

$$= .413\, P$$

Thus where the frictional coefficient is .280 between the belting material and metal, the belt going half way round the pulley so grips it that a force of .413 of the pull on the shaft would be required to slip the belt. Thus the gain is in the ratio of $\frac{413}{100}$ or nearly $1\frac{1}{2}$.

BOOKS RECEIVED.

Transactions of South African Institute of Electrical Engineers. Vol. 1, Part 1. Published by the Institute, Johannesburg, South Africa.

The initial number of this publication of the most recently organized association of electrical engineers contains the constitution and by-laws of the body, a list of the foundation members and minutes of the first annual meeting which was concerned with the formation of the Institute.

"Automobile Driving Self-Taught." "Ignition Timing and Valve Setting." By Thomas H. Russell; 222 pages each; 5½x7½ in.; leather bound. Charles C. Thompson, Chicago, Ill. ,and the Technical Book Shop, San Francisco. Price, $1.50 each.

Each of these books is written in an interesting manner by an authority on the subject of automobiles. The former contains suggestions on automobile driving which are as valuable to the expert as to the novice. The latter is primarily intended for the man caring for his own car and is eminently practical. Both are well illustrated and printed.

Preliminary Report Utah Conservation Commission. 128 pages; 6x9 in., and map of Utah. Published for free distribution by the Utah State Conservation Committee, Salt Lake City, Utah.

The Utah State Conservation Commission was established by legislative act in 1909 and now consists of eight members including the Governor. This, their first report, tells of the natural resources of the State of Utah in addition to various suggestions as to how they may be best conserved. These resources are classified as land, water, mineral, food products, game and timber, the mineral predominating.

Engineering Diagrams. By Manifold & Poole. A collection of straight line diagrams assembled in a leather bound loose leaf note-book 4½x7½ in. Published by the Technical Book Shop, 604 Mission St., San Francisco. Price $3.00.

These diagrams are ingenious and convenient devices for rapidly calculating engineering problems. Their main object is to give quick and approximately correct answers to questions that most frequently arise in field work. Each diagram consists of three or more vertical scales. From a known point on one scale a line is carried to a known point on another scale, and where it cuts the remaining scales readings are made which are solutions to the problems. A celluloid index is provided for carrying the line.

Problems solved by these means include the determination of the safe load to be carried by piles, knowing the penetration under the last blow of the hammer of known weight dropping a known distance, the determination of the depth of the keystone for brick and cut stone arches, for various spans and rises, also the horizontal thrust for each 1000 pound pound load and the ratio of rise to span; the sag and the strain in copper and aluminum wire for various spans and the temperatures, the actual amperes transmitted at various power factors for single-phase and three-phase electric current, knowing the voltage and either the kw. or h.p. transmitted, the determination of the impedance and volt drop per mile of single-phase and three-phase current for different sized wires with different interspacial distances; earth canal data based on Tuton's formula; power developed by water or necessary for pumping; steel and wood stove-pipe specifications for various diameters and pressures and the flow of water in pipes canals and flumes for all values of n. Additional diagrams dealing with reinforced concrete reactance, capacity and regulation of transmission lines, economical sizes of pipe lines, friction losses in small pipes, strength of gears, driving power of shafts, belts, etc., are in preparation.

The procedure in each of these cases is reversible so that it is possible to find specifications to meet given conditions or find the conditions over existing lines. Incidentally they give a graphic idea of the effect of changing conditions. This note-book should prove an invaluable pocket companion and time saver to the engineer.

JOURNAL OF ELECTRICITY
POWER AND GAS

PUBLISHED WEEKLY BY THE

Technical Publishing Company

E. B. STRONG, President
A. H. HALLORAN, Vice President and Managing Editor
C. L. CORY, Secretary.

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TERMS OF SUBSCRIPTION

United States, Cuba and Mexico	per year,	$2.50
Dominion of Canada	"	3.50
Other Foreign Countries within the Postal Union	"	5.00
Single Copies, Current Month	each	.10
Single Copies, prior to Current Month	"	.25

NOTICE TO ADVERTISERS

Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
Entry changed to "The Journal of Electricity," September, 1895.
Entry changed to "The Journal of Electricity, Power and Gas," August 15, 1899.
Entry changed May 1, 1906, to "The Journal of Electricity, Power and Gas," Weekly.

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CORRECTION.—Line 26 in the article on "Co-operation" in the issue of February 26th should read "this does not mean combination."

OMISSION.—The articles on "Fuel Oil Burning," by R. F. Chevalier, which were scheduled for publication in this issue, have been delayed owing to Mr. Chevalier's illness. It is hoped that this valued series can be commenced with the issue of March 19th.

Electric Meters

To the great uninitiated an electric meter is a diabolical mechanism, a sort of a perpetual motion machine that mysteriously measures electricity. The average man or woman regards a meter much as a child does a watch when he wants to know "what makes the wheels go round." As a matter of fact, an electric meter is as simple as an electric motor whose revolutions are counted by a cyclometer. Current passing through the meter causes an aluminum disc to revolve. The more current, the faster the disc revolves; the less, the slower. The revolutions of the disc are transmitted by gears to the hands of the registering dials.

There are usually four of these dials placed in the same order as are the numbers in a column of figures arranged for addition. The right hand dial records units, the next tens, the next hundreds and the next thousands of kilowatt-hours, the kilo (1000) watt-hour being the basis of electric measurement just as dollars are the basis of our monetary system. A twenty-five watt tungsten lamp giving 20 candlepower lighted for forty hours consumes one kilowatt-hour, as do likewise forty similar lamps burning for one hour. The record is cumulative, one months' reading being subtracted from that of the previous month to ascertain the quantity used. This quantity multiplied by the unit price gives the bill.

Many electric light and power companies give their consumers instructions for reading their meters and thus encourage checking of bills. This policy creates confidence and engenders a sentiment of good will. It is probable that this friendly feeling would be further enhanced if a glass-case meter connected with a number of lights were placed in the company's office so as to be of easy access to bill payers. The cash register and the visible weighing scale are important factors in retail business because they remove distrust from the customer's mind. Frankness disarms the suspicion that attends the unknown.

It is well also that the collectors and meter readers be familiar with some of the facts that are being told in the series of articles regarding the watt-hour meter now appearing in these columns. A moment's explanation may save much groundless dissatisfaction among customers. We realize the danger that attends too intimate an understanding of meter construction by the unscrupulous, and furthermore we appreciate that "where ignorance is bliss, 'tis follow to be wise"; nevertheless, we have enough confidence in human nature to believe that the more a consumer knows about the instrument that measures his current the better satisfied he is.

PERSONALS.

Sidney Sprout of San Francisco, is in Oregon on an electrical engineering investigation.

A. C. Sprout, of Hall, Demarest & Co., engineers, is making a business trip to Keeler, Cal.

F. G. Decker has been appointed acting manager of the San Francisco office of the Platt Iron Works.

Leon M. Hall, consulting engineer for the Comstock mines, is visiting Virginia City on professional business.

M. C. Miller, assistant to the president of the Allis-Chalmers Company, of Milwaukee, Wis., is in San Francisco.

C. E. Gilman, of Duryea, Haehl & Gilman, engineers, will be manager of the Bay Cities Water Company of Oakland, Cal.

W. H. Schott, of W. H. Schott & Co., electrical engineers, of Chicago, who has been touring the Coast, is a guest at the Palace in San Francisco.

Bernard Corrigan, who has been president of the street railway system in Kansas City, has been touring California and is now a San Francisco visitor.

B. M. Downs, general manager of the Brookfield Glass Company, of New York, who has been making a business tour of the coast, returned from Seattle during the past week and left for Los Angeles March 2d.

C. S. Hancox, electrical engineer for the Queensland Government, Australia, left for the East last week after spending ten days in inspecting electrical installations in San Francisco. He expressed himself as much pleased with some of the new things he saw.

C. E. Groesbeck of San Diego and W. D. Riddell of Tacoma, who are interested in lighting plants in their respective cities, recently accompanied R. S. Chapman to Eureka, where an option was secured on the Humboldt Gas & Electric Co.'s holdings. A hydro-electric plant on the Trinity river is operated by the company and a steam plant in Eureka.

R. S. Chapman, representing H. M. Byllesby & Co. of Chicago, who have been extensively engaged in buying up gas and electric lighting properties throughout the Pacific Coast, has returned from a northern trip. Options have been taken on the plants of the Klamath Falls Light & Water Company and Moore Bros. Electric Company at Klamath Falls, Ore.

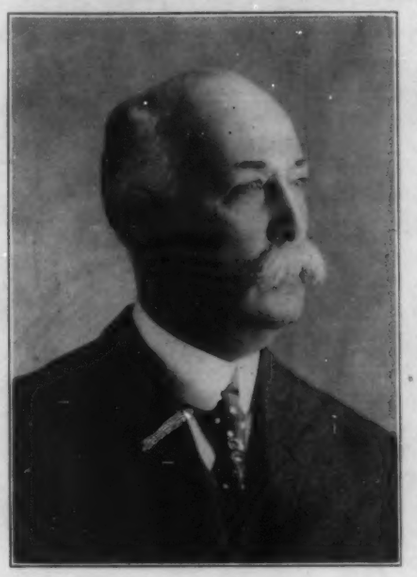
D. C. Henry, consulting engineer, Beck Building, Portland, Oregon, announces that the Secretary of the Interior has approved his request to be placed on a per diem basis as consulting engineer with the service instead of an annual basis as heretofore. This change will enable him to engage in private practice without severing connection with the service. Mr. Henry has been consulting engineer with the service for one year prior to which he was supervising engineer for the Pacific Coast District, embracing Washington, Oregon, Northern California and Nevada, in which states a large amount of work was done under his supervision, aggregating approximately ten million dollars, including numerous dams for irrigation storage reservoirs and diversion.

TRADE NOTES.

The Portland, Oregon, offices of the General Electric Company have been moved to the Electric Building at Seventh and Alder streets.

Hunt, Mirk & Co., of San Francisco, Pacific Coast agents for the Westinghouse Machine Company, have sold the largest Westinghouse-Parsons turbo-generator in this country to the Southern California Edison Company. It will be installed in a new power station, which is to be erected at one of the ocean beaches contiguous to Los Angeles. The contract calls for a 12,500 kw. machine with 75 per cent overload capacity. Contracts for auxiliaries and boilers are still pending.

W. S. Heger has accepted the management of the San Francisco office of the Allis-Chalmers Company, in addition to his present duties as manager of the company's Los Angeles office, succeeding R. B. Elder who has resigned as acting manager of the San Francisco office. Mr. Heger has been actively associated with the sale of electrical and power apparatus on the Pacific Coast for more than twenty years. In 1889 he opened the San Francisco offices of the Edison Company for Isolated Lighting which was finally merged in the General Electric Company. For ten years following 1895 he was Pacific Coast manager of the Westinghouse Electric & Manufacturing Company, having established their offices here. In 1905 he resigned to become assistant to the president of the Allis-Chalmers Company, but in 1909 his many friends again welcomed him to the Coast when he assumed charge of the Los Angeles office of the company.



THE ELECTRIC STORAGE BATTERY COMPANY.

Announcement is made by the Electric Storage Battery Company of Philadelphia, Pa., that they have discontinued their San Francisco office, and, taking effect March 1, 1910, have appointed Pierson, Roeding & Co. as their sole Pacific Coast Selling Agents. Mr. George R. Murphy, a member of the corporation of Pierson, Roeding & Co., will be in charge of the new department, his long experience as the Pacific Coast engineer with the Electric Storage Battery Company particularly fitting him to handle both the technical and commercial branches of their varied interests.

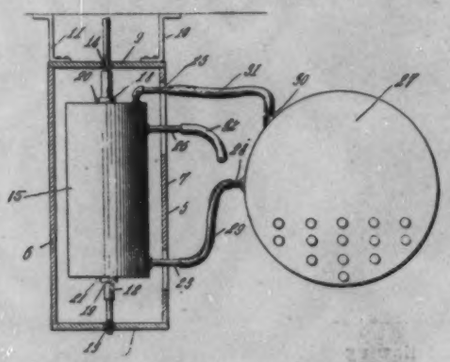
Recent advances in secondary distribution and the tremendous strides in the electric automobile have greatly enlarged the scope of the battery company, and they will now have the benefit of a selling and engineering organization, with branch offices in Seattle and Los Angeles, that will enable them to care for their product with a maximum efficiency.

Pierson, Roeding & Co. will not only handle the well-known "Chloride Accumulator," but will have under their control a well-equipped depot for the supply of the "Exide Battery," with its various parts, from a large stock carried in San Francisco. The new agents will temporarily carry on the business of this department at the former office of the Electric Storage Battery Company in the Crocker Building, San Francisco, and at the office of the Exide Battery Depots, Inc., 590 Howard street. It is planned to eventually consolidate all departments in new and commodious quarters. Pierson, Roeding & Co. are to be congratulated upon adding to the field of their activities another large Eastern manufacturing company whose product is of such importance to the electrical interests of the Coast.

The San Francisco office of the Allis-Chalmers Co., has closed a contract with the Nevada-California Electric Power Company for the first generator for a new power house on their Bishop creek development in California.

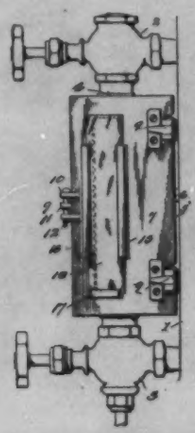
PATENTS

949,896. Feed-Water Regulator. Arthur R. Herlache, Brussels, Wis. In a feed water regulator, the combination with a boiler; of a supporting frame arranged exteriorly of the boiler, a vertically disposed shaft having its opposite ends secured in the opposite ends of said frame, a cylinder adjustably secured to said shaft, said cylinder having a water-inlet at one end, a steam inlet at the other end and flexible



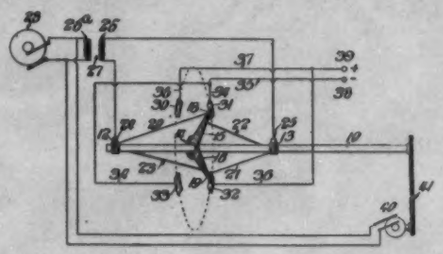
connections between the boiler and said steam and water inlets, said cylinder being further provided with a steam outlet arranged adjacent the said steam inlet, and a piston within the cylinder and slidingly fitted on said shaft and operable by the pressure of water and steam in the boiler to open and close communication between said steam inlet and outlet.

949,800. Water-Glass Shield. Hugh Montgomery and Frank G. Drolet, Milo Junction, Me. In a water-gage-glass protector, the combination with a boiler head, a water-gage-glass, water-gage connections arranged upon said boiler head



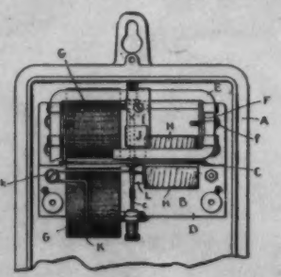
for supporting said water-gage-glass, of a back plate detachably secured to said boiler head, sides swingingly mounted upon said back plate and arranged to engage each other and form a triangular casing inclosing said water-gage-glass, a sight opening in each of said sides, and transparent material covering the same.

950,124. High-Potential-Alternating-Current Rectifier. Chester H. Thordarson, Chicago, Ill. A high potential alternating current rectifying apparatus comprising a plurality of rotative angularly separated, elongated, relatively light, thin arms made of non-conducting material and provided with means for bracing them from flexure out of the plane of rotation thereof and revolving at a speed in synchronism with the frequency of the alternating current to be rectified, commutator members located at the outer ends of said arms and connected with a source supplying alternating current, and a plurality of angularly separated collector plates arranged on the circumference of a circle described by said commutator



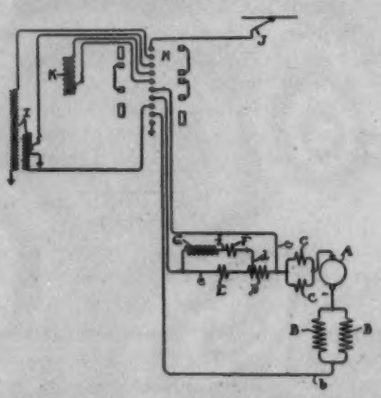
members with which the said commutator members are adapted for wiping contact, said collector plates collecting from the commutator members opposite polarities of an unidirectional current.

950,079. Electric Meter. Gustave A. Scheeffer, Fort Wayne, Ind., assignor to General Electric Company. In an electric meter, a rectangular core of magnetic material having an air-gap cutting one of the shorter sides of the rectangle and poles projecting toward each other from points near the



centers of the longer sides of the rectangle, a shunt winding surrounding the core and so positioned that the shortest magnetic circuit therefor is through that portion of the rectangle having a closed magnetic circuit and through the projecting poles, and a disk armature projecting between said projecting poles.

949,992. Commutator-Motor. Ernst F. W. Alexanderson, Schenectady, N. Y., assignor to General Electric Company. A motor of the commutator type, adapted for operation on both direct and alternating-current, having a portion of its stator winding connected to another portion of



said winding and forming with said other portion and the connections between them a local closed circuit, and connections for including said portions in the main motor circuit for direct-current operation and excluding them therefrom for alternating-current operation.

INDUSTRIAL

A NEW PREPAYMENT METER.

To many householders the "pay-as-you-go" method of meeting expenses is much preferable to the monthly bill system, with its attendant bother. To persons of limited means, monthly payments are often a hardship. Each of these classes offers a broad field for the sale of electric current, and to enable the central station to make a more effective campaign for this business, new prepayment attachments for use with either direct or alternating current Thomson watt-hour meters have recently been perfected by the General Electric Company. Aside from the advantages as stated above, prepayment meters often act as a safeguard of the supply company's interests, for this device is an absolute protection against loss from unpaid bills and saves the expense of keeping a consumer's account, sending bills, and the several steps which must be taken before payments can be collected from some consumers.

This prepayment device is suppied either in combination with, or separate from the meter. Arrangements similar to those shown in the illustrations are made for direct current meters. The advantages of a separate attachment for some cases will be apparent, for although it is not always desirable to place the wattmeter proper in a location convenient to the consumer, the prepayment attachment can be installed wherever most desirable. The principle of operation is identical in either case except that the connection between meter and attachment is mechanical in the case of the combination and electrical in the other instance. The

Fig. 1.

Thomson High Torque Watt-Hour Meter with Combined Prepayment Device — Type IP 3 — for Alternating Current.

attachment consists of four principal parts, the escapement train, coin device, switch and rate device.

When it is desired to make an advance payment the winding knob is turned so that the arrow points upward. A quarter dollar is then inserted in the slot and the knob turned to the right, the coin serving as a key which operates the mechanism within the device, turning the registering wheel and placing the coin to the credit of the consumer. If the circuit is open when the coin is deposited, the same motion of the knob which moves the registering mechanism closes the circuit switch contained within the case of the attachment.

The dial of the combined prepayment meter is enlarged and contains in addition to the standard marking, a scale marked in plain figures over which a pointer passes indicating the number of coins remaining to the credit of the depositor. When the meter has a separate prepayment attachment, the dial showing the number of coins standing to the customer's credit, is placed on the attachment.

When the first coin is deposited and the knob is turned, closing the main switch, the pointer rests opposite the first division on the scale. If a second coin is deposited before the current purchased with the first coin has been consumed, a second motion of the knob will bring the pointer opposite the second division on the scale. Twelve coins can thus be deposited consecutively, after which the slot is automatically closed and further prepayment cannot be made until the value of one or more coins has been consumed.

Whenever energy to the value of one coin has been delivered through the meter, the escapement is released (mechanically in the combined device, and electrically in the separate device) turning the pointer back one division. This process continues until all the energy for which prepayment has been made has been delivered. Thus the depositor can ascertain at any time how much energy can be obtained without further prepayment.

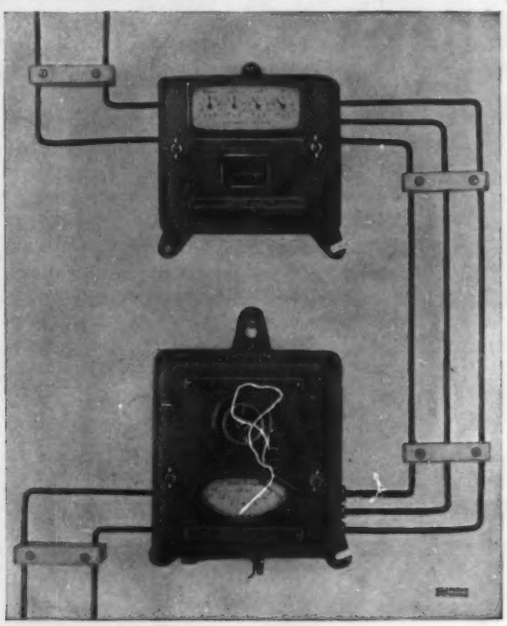


Fig. 2.

Thomson High Torque Watt-Hour Meter with Separate Prepayment Device—Type IP—for Alternating Current.

When all the energy has been delivered, the circuit switch is opened and no more current can be obtained until further prepayment has been made.

The indicating mechanism shows only the number of coins which stand to the credit of the customer; but by consulting the meter dial one can determine what fractional part remains of the prepayment next to be cancelled.

The actuating force which operates the device is a large flat coil spring enclosed in a barrel or drum to which its outside end is attached. The operating knob winds this main spring by turning the drum. The spring has many turns and as the operation of the device never equals one whole turn, the spring always exerts a practically constant force.

The rate device consists of a small train of gears secured to the front of the frame directly back of the register, the gear ratio depending upon the price charged for the service.

Each device is marked with the price per kilowatt-hour for which it should be used. It will be noted that this device is a separate member secured independently to the meter frame so that it can be easily removed and replaced by the electric lighting company in case the rate of charge is changed. The meter can be adapted to any rate of charge from 5 to 20 cents per kilowatt-hour in steps of ½ cent.

The switch is of the double pole, double break type with leaf contacts, the construction being similar to that used in heavy current circuit breakers. The toggle joint used to close the switch arms against the terminal blocks makes it impossible for the switch to open through accidental jar and also prevents any back pressure from being transmitted to the escapement train in such a way as to retard its action. The switch is liberally rated and will without injury to itself open any circuit carrying current up to the maximum overload allowable for the largest meter with which the device can be used.

The standard prepayment device is designed for use with quarter dollars. The coin receptacles are placed at the back of the meters so that the covers may be removed without interfering with the receptacle in any way. This feature permits the meter to be tested without affording access to the coin box, besides the collector, who is usually unfamiliar with the electrical features of the meter, cannot inadvertently injure its adjustment. The coins fall into a drawer which is removable from the bottom of the case and which can be secured by either a seal or any suitable padlock. The slot in which the coin is inserted is situated at the top of the meter case near the back.

Every precaution has been taken to guard against beating. A coin or washer larger than the coin for which the device is designed cannot be introduced into the receiving slot and a smaller one will not operate the device. The knob, once started with the coin locked in, cannot be reversed, but must be given a half turn to release the coin, which falls through a tube to the money box below. The coin is locked in as soon as the knob is moved and cannot be abstracted except by unlocking the money box. It is only by turning the knob that the consumer can obtain credit for his payment. A coin having a thread or wire attached will operate the mechanism, but the motion of the actuating handle prevents the withdrawal of the coin, which generally passes into the receiving box. Should bits of string prevent the coin from passing to the drawer, the intended fraud will be readily detected.

A MODERN ELECTRICALLY EQUIPPED ICE CREAM FACTORY.

An example of the modern ice cream factory employing the latest methods of production is that of E. A. Caum at Altoona, Pa. This plant has a capacity for making and storing 3000 gallons of ice cream daily, besides producing ten tons of ice and the equivalent of 30 tons of refrigeration. This latter brine refrigerating system is used to reduce the temperature in two ice storage rooms, two milk and cream rooms, two hardening rooms, and the retail sales cabinets, besides removing heat from the ice making apparatus and the ice cream mixing and freezing machines.

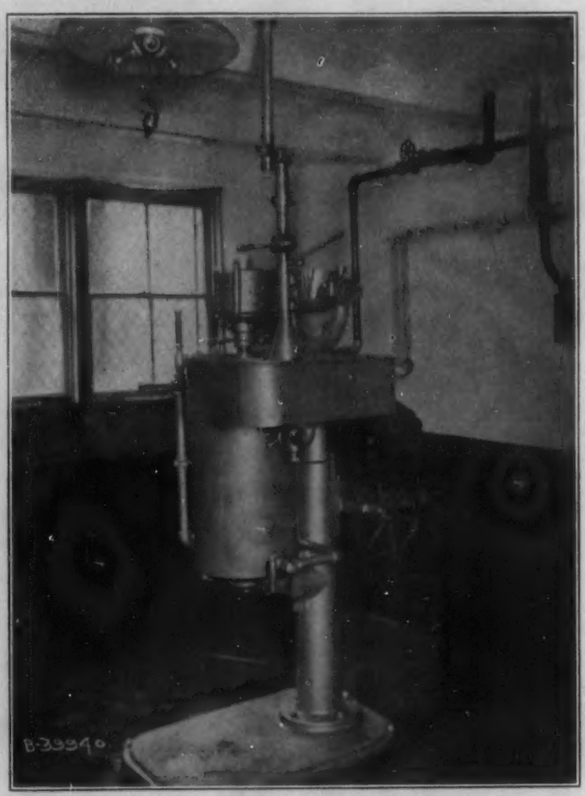
The brine in the refrigerating system is cooled by the expansion of ammonia gas, previously liquified by a 30-ton Larsen-Baker compressor. This compressor is driven through a Morse chain transmission by a 50 h. p. 200 volt, 60 cycle, two-phase type "CCL" Westinghouse induction motor. The brine is circulated by a five-inch Aldrich triple brine pump driven by a 5 h. p. Westinghouse type "CCL" motor.

In the ice cream making department, two Miller Duplex ice cream mixers, having a capacity of 150 gallons each, are installed. These are connected by German silver pipes to the refrigerating system, and are driven by two horsepower Westinghouse type "CCL" motors.

Directly underneath the mixing room is the freezing department where are located two Miller upright cream freezers, each of 60 gallons capacity per hour, and similarly chain driven by Westinghouse motors. In these machines connection to the refrigerating system takes the place of ice for the freezing operation. After being partly frozen in these machines, the cream is run out into the delivery cans of various sizes and transferred to the cooling rooms where it remains until sold.

Before refrigeration was installed, the common practice was followed by putting the ice cream as frozen into a big tub, from which it was measured into the cans and packed for shipment. This required packing the cream twice daily, and the ice bills alone at that time amounted to $15 or $20 a day, a figure which contrasts greatly with the present total cost of running the plant since refrigeraion has been operated.

A Creasy ice crusher and pasteurizing machine and butter churn and worker are also installed in the Caum factory, being driven by 3 h. p. Westinghouse type "CCL" motor. Two 16-inch Hill deep well pumps, each capable of delivering 50 gallons of water per minute, are driven by 5 h. p. Westinghouse "CCL" motors.



Motor Driven Ice Cream Freezer.

The power supplied to the plant is two-phase, 60 cycle alternating current at 200 volts. All the motors are controlled from a starting panel which carries the auto-starter for the 50 h. p. motor, the simple starting switches for throwing the other machines across the line, the lighting snap switches, and the service watt-hour meter.

The present connected motor load aggregates 72 h. p., which is operated from two and one-half to three hours per day. For this service the power bill is about $55 monthly, which covers all the costs of pumping, refrigerating, freezing and churning. As noted before, the daily ice bill alone, before refrigeration was installed, amounted sometimes to $20 per day.

NEW TUNGSTEN FIXTURES.

Two new tungsten fixtures have recently been added to the Benjamin Electric Mfg. Co.'s list for store, shop and factory lighting. Besides being substantially constructed, both are inexpensive, and may be used with low-voltage street series lamps having small Edison base, thus taking advantage of this important recent factor in efficient incandescent lighting.

The fixture shown in Fig. 1 has cluster body with enameled steel reflector plate, 15-in. stem of ⅜-in. iron pipe and ¾-in. brass casing, 18-in. opal reflector, 5 in. x 4 in. canopy, and

Fig. 1.

Fig. 2.

crowfoot, 2, 3 and 4-light fixtures will take 100-watt lamps. This fixture is neat in appearance and is especially adapted for stores and offices.

The fixture shown in Fig. 2 has a tungsten cluster, 18 in. deeply hooded enameled steel reflector, 12 in. stem ⅜ in. iron pipe, and shock absorber, 2, 3, and 4-light fixtures will take 100-watt lamps. Those contemplating factory, shop or warehouse installations will find them especially serviceable.

Both fixtures in question are made from 2 to 5 lights and as indicated may be furnished either in multiple or series.

BATTERY CHARGING RHEOSTATS.

In the rush and bustle of modern life many of the devices which contribute to our pleasure or assist us in business have features which may become a source of great annoyance, due to the difficulty of keeping them in a serviceable

Battery Charging Rheostat.

condition. This may lead to so much delay and inconvenience that the owner will gladly avail himself of any means of avoiding this unpleasant state of affairs.

The wide application of storage batteries as a source of power for electric automobiles, launches, etc., has made it imperative that means be provided for quickly charging them and that the apparatus be so simple that the charging may be done by anyone. The owner may then charge his own battery on his own premises.

Wherever a 125-volt direct-current circuit is available this may be easily accomplished without the use of expensive apparatus by the use of a General Electric CR 211 battery charging rheostat. It is simple in mechanical construction, of rugged design, and has a maximum current capacity amply sufficient to meet all conditions of service.

In order to prevent any possibility of accidental contact with live parts, the rheostat is thoroughly insulated and entirely enclosed by a cover so constructed as to permit of thorough ventilation.

These rheostats are very compact, present a very neat appearance and may be installed in any place. All parts are readily accessible for inspection and repairs.

Before closing the main switch to charge the battery, the handle should be moved as far from the supporting feet of the rheostat as possible. After the switch has been closed the handle may be moved toward the feet of the rheostat to regulate the current for charging.

MARINE ELECTRIC LIGHT FIXTURES.

The electrical appliances used on board ship must of necessity be constructed with special reference to the conditions under which they will have to be used. A source of light must be guarded from injury by a strong metallic guard capable of withstanding the impact of anything that may come in contact with it, such as freight that may be standing against it, or ropes. And it is equally important that it should be impregnable to moisture, as the electrolic action on current carrying parts is very rapid when such parts become wet with salt water.

Marine Fixtures and Guards.

Buxbaum & Cooley of Seattle manufacture a line of electric fixtures designed to meet the conditions of marine service. The accompanying illustration shows their No. 118 fixture with No. 63 guard. A test of several years' use has proved them to be able to meet all the conditions required

NEWS NOTES

INCORPORATIONS

ARCO, IDAHO.—The Arco Telephone Company has been incorporated for $1,500 by John W. Fowler et al.

TAMPICO, WASH.—The Tampico Telephone Company has been incorporated for $4,000 by Wm. O'Neal et al.

RUPERT, IDAHO.—The Rupert Electric Company of Rupert, with a capital stock of $10,000 has been incorporated by F. M. Victor and A. C. Brown.

PORT TOWNSEND, WASH.—The Key City Light & Power Company has been incorporated with a capital of $80,000 by John Siebenbaum et al.

SEATTLE, WASH.—The Glacier Development Company, capital $1,000,000 has been incorporated by B. Thomas and W. C. Berg, to supply electric power for heating, lighting, etc.

LOS ANGELES, CAL.—The Southern California Manufacturing Company has been organized with a capital of $50,000 by L. M. Ellis, manager of Union Home Telephone & Telegraph Corporation in the I. W. Hellman Building. The Company will have a plant at Long Beach, and manufacture telephone supplies.

SAN DIEGO, CAL.—The Lakeside Farmers' Mutual Water Company with a capital of $25,000 has been incorporated. The Directors are: G. J. Bach, F. L. Leber and O. E. Busenberg. The Company will deal in and improve real estate, construct ditches, reservoirs and other essentials for collecting and impounding of water upon its own property.

TRANSMISSION.

SAN DIEGO, CAL.—The Spreckels interest has leased the land on which the Akerman & Tuffleu olive factory at Old Town now stands, to erect a power house.

TACOMA, WASH.—Wright, Sweeney & Cummings, Tacoma, submitted low bid, $655,225.50, for the construction of the tunnel for the municipal power plant on the Nisqually river.

UNDERWOOD, WASH.—Dement Bros. of Walla Walla who are to build the flouring mill here have secured a power site two miles up the White Salmon river where a dam 80 feet high will be constructed and a power plant installed.

SEATTLE, WASH.—The Pacific Coast Power Company has secured the right to divert 2000 ft. per second of the waters of White river to Lake Tapps for the development of 30,000 electric horsepower. The power house will be located on Stuck river.

FORT BAYARD, N. M.—Contracts for a central power plant and a hospital sergeants' quarters at Ft. Bayard have been let. J. A. Harlan was the lowest bidder on construction work of both power plant and hospital sergeants' quarters, his bid on power plant being $33,322 and on quarters $7250.

PORT ANGELES, CAL.—An ordinance has been presented granting a franchise to the Port Angeles Power and Electric Company for the distribution and sale of electric power, heat and light within the limits of the city, for a period of twenty-five years. The franchise stipulates that guarantees shall, within one month after acceptance, begin the construction of a hydroelectric power plant on Little river.

AUBURN, CAL.—A surveying party, headed by Adrian Wills, an Auburn surveyor, is now engaged in running lines and taking levels between Forest Hill and Auburn by direction of William Muir, the mining man, who contemplates bringing water from just below Forest Hill to Green Point, at the junction of the North and Middle Forks of the American River about three miles east of Auburn. It is stated that Muir will erect a power plant at Green Point to generate from 25,000 to 30,000 horsepower. The specifications call for two ditches, extending from near Forest Hill to Green Point, a distance of 20 miles. The two water ditches will meet at Green Point, where the proposed power plant will be, the fall being close to 600 feet.

SAN DIEGO, CAL.—The San Diego Electric Railway Company is planning to increase its generating facilities and has recently placed an order with Allis-Chalmers Company for a 28 and 60 by 48 vertical cross-compound condensing engine. This will be supplied with steam at 160-pound pressure and a vacuum of 26 inches will be maintained. The engine will operate at 80 r.p.m.

RED BLUFF, CAL.—Dr. J. M. West has filed a notice in the office of the County Recorder claiming 300,000 inches of water of the Sacramento river, to be taken out at the mouth of Red Bank creek, which is about three miles south of Red Bluff. The water is to be used in Tehama, Glenn, Colusa and Yolo counties for irrigation, generating electricity, domestic and other uses. The amount of water claimed would be practically all the water of the river and would be sufficient to irrigate many thousands of acres of land. Dr. West claims he is working in the interests of the Tehama County Power and Transportation Company, of which he is a director. This company was organized some years ago, and has filings on waters along Mill Creek for power purposes. He also states that Eastern capitalists are negotiating with his company with a view to taking over its holdings.

TRANSPORTATION.

VANCOUVER, B. C.—The B. C. Electric Railway will soon begin construction of its line on Broadway east from Scott street to Park drive.

WENATCHEE, WASH.—The Wenatchee Valley Railway & Power Company is asking a franchise in the city and proposes to extend its lines to Leavenworth and other towns if same is granted.

BUTTE, MONT.—An ordinance has been passed by the City Council for the building of an electric ore line by the Davis-Daly Company from the Colorado mine to the N. P. to connect with the Great Northern.

NORTH PASADENA, CAL.—Surveyors were at work on North Los Robles avenue preparing for a gang of workmen who are soon expected to start laying the extension of the Los Robles avenue car line to the city limits.

SAN JOSE, CAL.—One result of the recent consolidation of the First Street Railroad system with the Santa Clara Street system has been the elimination of the fare-books whereby 26 rides could be bought for $1. Hereafter the 5-cent fare will be collected.

LOS ANGELES, CAL.—City Attorney Hewitt has been authorized by the City Council to draft an ordinance providing for the construction by the Pacific Electric Railway Company of an overhead crossing on the Mission Road. The work will cost about $86,000.

LOS ANGELES, CAL.—Judge Bordwell has handed down a decision quieting the title of the Los Angeles Pacific Railway Company, to a 20-foot strip of right of way near Hollywood. The decision was granted against Carl Schultz, who asked $2000 damages in a cross complaint for alleged injury to the trees on his land.

PENDLETON, ORE.—Work is to be started on the Pendleton City & Interurban traction line in the near future. The Washington & Oregon Traction Company which is to build this system has agreed under bond to build six miles of road within the city within a year's time.

SACRAMENTO, CAL.—No time was lost by the Central Traction Company in resuming work on its road between this city and Stockton, after which temporary injunction which stopped work on the Upper Stockton road was dissolved. Four big construction gangs went to work between this city and the Cosumnes River.

LOS ANGELES, CAL.—It is expected that cars will run over the new Seventh street bridge about March 1st. This is on the Los Angeles railway company's system and the cars will run from the western extension of Washington and Seventh streets across the river to Boyle Heights and by way of Stephenson avenue and Downey road out into the eastern country.

COVINA, CAL.—The Covina electric line will continue east on Badillo street to a point two miles east of Covina, thence in a northeasterly direction to Covina avenue. It will enter the town of San Dimas where it will be joined by the extension from Glendora. From San Dimas the line will run direct to Claremont and join the Kerchoff line now being constructed from Pomona to Claremont.

SALT LAKE, UTAH—Contracts have been awarded by the board of public works for the laying of all water mains in the city during this year, and also for the construction of a concrete conduit in Parley's creek at Twelfth South street, for a distance of about 400 feet. P. J. Moran was awarded the contract for the water mains upon his bid of $49,438.60. The Moran Construction Company of Ogden was awarded the Twelfth South street contract on its bid of $5895.98.

FRESNO, CAL.—A conference of Fresno and Kings county bankers was held in this city this week to consider the endorsing of the $150,000 worth of bonds to be floated by the Fresno-Hanford Railroad Company. It is understood that if they are endorsed by the Fresno and Kings county bankers, a San Francisco capitalist stands ready to take them up immediately. In the contract drawn up between the Fresno-Hanford Railway Company and the Hudson Counties Improvement Company, one of the provisions was that the Hudson Counties Company would furnish $650,000 and build the proposed road if the local company furnished $150,000. The officers of the local company are now seeking to float bonds for this amount.

ILLUMINATION.

COLTON, CAL.—A contract has been awarded for the Central gas plant at Colton with 2,000,000 feet capacity which will cost $132,000.

NEWPORT BEACH, CAL.—The Trustees have accepted the bid of J. H. Adams & Co. for bonds recently voted by the city—$25,000 light and $40,000 water, bearing 5 per cent interest.

EVERETT, WASH.—An ordinance was introduced granting the Seattle-Tacoma Power Company, a franchise for light poles on First street, from the eastern city limits to Maple, thence two blocks on Maple to the river.

NEEDLES, CAL.—The Needles Light & Power people contemplate a number of improvements on their plant. Work will begin shortly on a concrete power house, about twice the size of the present one. An additional engine and generator will be added to the present equipment.

GRIDLEY, CAL.—An ordinance has been passed calling a special election to be held on March 5, 1910, at which time will be submitted the question of issuing and selling bonds in the amount of $17,500 for the acquisition, completion, extension and maintenance of an electric light and power plant and distributing system and certain franchise, contracts and equipment for the city of Gridley.

OROVILLE, CAL.—The report that this company intended to begin work upon the construction of its dam at Humbug Valley this summer is denied by the manager of the Oroville Water, Light & Power Company, R. Leo Van der Naillen, Mr. Van der Naillen states that while the company intends ultimately to establish a power plant there, there is nothing in contemplation for the immediate future.

LOS ANGELES, CAL.—The Southern California Edison Co. has applied to the Supervisors for a franchise to construct and erect and for a period of 40 years to maintain and operate, all piers, masts, poles, etc., upon or from which to suspend, affix and hang wires, cables or other appliances for transmitting electricity; also to lay, maintain and operate wires, cables, etc., to transmit electricity over, under and across certain county roads, highways, etc., within the county of Los Angeles, commencing at the north boundary of the City of Pomona.

TELEPHONE AND TELEGRAPH.

JACKSONVILLE, ORE.—E. C. Sharpe et al have been granted a franchise to install a telephone system, etc., here.

CHENEY, WASH.—The Washington Southern Telephone Company of Spokane has applied for a telephone franchise here.

ROSEVILLE, CAL.—Manager Bryson was authorized to build a telephone line from Alta to Rawhide along the present trail and country road.

POCATELLO, IDAHO.—The Bell Telephone Company is planning to extend its Hollister line to the Salmon river dam and from there to Jarbidge.

RITZVILLE, WASH.—The Washington Southern Telephone Company of Spokane has made application for a franchise to install a telephone system here.

SAN FRANCISCO, CAL.—The Western Union Telegraph Company, through its local officers, announces that hereafter it will receive and transmit messages telephoned to its offices.

SANDPOINT, IDAHO.—M. A. Phelps, general manager of the Interstate Telephone Company, announces that the company will extend its system so as to give a general long distance service both east and west.

MEDICAL LAKE, WASH.—B. F. Nail has been elected president of a telephone company which will run a line from there to Denny Bluffs and from there to Waukon to be known as the West Lake Telephone Company.

LOS ANGELES, CAL.—The Pacific Telephone and Telegraph Company has acquired from the Monrovia Home Telephone and Telegraph Company all of the business in a district including the cities of Monrovia, Duarte, Arcadia and Santa Anita, in the San Gabriel valley.

LOS ANGELES, CAL.—It is proposed that subscribers to either the Home or the Pacific Telephone and Telegraph companies in Los Angeles be enabled to obtain connection on the system to which they are not subscribers by the payment of five cents for each switch. This matter is to be taken up by the new board of public utilities.

SAN FRANCISCO, CAL.—It will require 21,000 telegraph poles, it is estimated, for the Postal Telegraph Company to build its new four wire line between Salt Lake and Reno the coming summer. The contract has been let in Michigan for the poles at a cost of $85,000. It will require 210 cars to freight them at a cost of $40,000. The work will need 2600

miles of copper wire, 350 pounds to the mile, a total of 910,000 pounds, or 455 tons to cost $136,500. This will give four more wires from Salt Lake to San Francisco.

REDLANDS, CAL.—The Directors and officers of the Southwestern Home Telephone Company were elected last week at a meeting held in the office of the company on Fourth street. The reports made by the officers were satisfactory to the stockholders. K. C. Wells, who has served as president of the company for the past several years, was again elected to that position by the directors. The list of officers and directors now stand as follows: President, K. C. Wells; vice-presidents, A. Gregory and Charles A. Rolfe; secretary and treasurer, J. J. Prendergast; other directors, Henry Fuller, W. F. Holt, J. F. Dostal.

WATERWORKS.

CENTRAL POINT, ORE.—A contract for the construction of the new water system has been awarded to the Jacobson-Bade Company of Portland, for $21,279.51.

BELLINGHAM, WASH.—The water board recommended to the City Council that the bid of Crane & Co., of Seattle, on a total of 20 tons of cast iron pipe be accepted. The bid was $34.50 per ton.

VALE, ORE.—Newbill & Coleman who were let a contract for boring a well to make a test for the city water, have reported going 29 feet and are now into a fine sand with any quantity of water.

ROSS, CAL.—Sealed bids will be received by the Board of Trustees for the furnishing and installation of six electrically driven centrifugal pumping plants with necessary equipment in the town of Ross.

SWANSEA, ARIZ.—The Clare Consolidated Gold and Copper Company at Swansea is preparing to install another pump and a 6-inch pipe line for conveying the water which is pumped from the river to Swansea.

EVERETT, WASH.—A pressure standpipe is to be erected by the Everett Railway, Light & Water Company to give service to the southwestern portion of the city too high to be taken care of by the reservoir.

LOS ANGELES, CAL.—At the earliest possible date a certificate of election will be filed with the Secretary of State and an ordinance calling for the harbor and power improvement bonds election may be passed upon by the Council.

COMARRON, N. M.—The Colfax County Commissioners have granted to H. H. Webster Jr. of Comarron, a franchise to construct a waterworks system to supply the town of Comarron with water for domestic and public purposes.

TACOMA, WASH.—Sealed proposals have been received by H. J. McGregor, commissioner of public works, for the construction of cast iron water mains on Adams street, Union avenue, South Seventh, Eighth, Ninth and Eleventh streets.

ASHLAND, ORE.—The fire and water committee has submitted reports recommending the laying of six-inch water mains for certain districts in the vicinity of Ashland street and boulevard and a four-inch pipe for the remainder of the territory.

HOOD RIVER, ORE.—The City Council has accepted bids on the municipal bond issue of $90,000 for a city water system and has awarded the handling of the securities to John Nuvoon & Co., bankers, of Chicago, who will pay a premium of $726 for the paper.

SILVER CITY, N. M.—The Silver City Water Company is sinking wells to the depth of 500 feet in locations where it is positive of securing a flow of water sufficient for all purposes, including new sewerage system which will be installed if the bond issue of $50,000 is voted.

MADERA, CAL.—Sealed bids are being received by the Board of Supervisors for the following: 400 feet black dip pipe, to have crosses every 15 feet; 1600 feet 2-inch pipe, galvanized; 100 feet 3-4 inch pipe, galvanized; 1 6-inch gate valve; 8 2-inch gate valves; 24 crosses, 6x6x2x2 inch; 100 T's 2x2x3x4 inch; 75 3-4 inch plugs; 16 2-inch plugs; 2 6-inch sleeves or couplings; 1 6-inch cap; 8 2-inch cap; 24 3-4 inch garden valves; 1 7x7x6 inch cast tee with hubs for calkings. ings.

SAN DIEGO, CAL.—An ordinance adopted by the City Council appropriates $1600 to cover the cost of constructing an eastern foundation for the steel tower tank which is to be erected on the property adjoining the Old University Heights reservoir for the purpose of giving a better water supply to that section of the city. The contract for constructing the foundation was awarded to W. G. E. Gabrielson for $1580. Other bidders were: Knight & Hyde, $2350; Clark & Goodbody, $1900; Olaf Nelson, $1710.

MEDFORD, ORE.—The City Council has passed resolutions providing for a six-inch water main on Jackson street from the end of the present main to Vermont street; a four-inch main on Thirteenth street from Newton street to Peach street; a four-inch main on Fourteenth street from Newton to Peach street; four-inch main on North Oak street, in Gray's Addition from Jackson street north to the end of North Oak street, and a four-inch main on Almond street from East Main street south, to the end of Almond street.

PASADENA, CAL.—The first step of importance in the merging of the three water companies of Pasadena into one public service corporation in an attempt to solve several dry tract problems of the city, was taken today, when the West Side Land and Water Company, the only one of the three in debt, issued an assessment levy of $2 per share on all stock. As a public service corporation, the merged company will be forced to furnish water to all parts of the city regardless of the stock issued by individual companies during their existence as mutual companies.

SAN FRANCISCO, CAL.—After several months of effort to effect a merger with the People's Water Company of Oakland, the Bay Cities Water Company, controlled by the Tevis interests, announces that all negotiations with the People's company are off and that it proposes to come into the market and sell water to the trans-bay municipalities in bulk. Up to last Wednesday there was a strong possibility that the merger scheme would be carried out, but the point was reached where neither side would give in and all negotiations were declared off. The People's company look upon the announcement of Mr. Tevis as largely bluff, on the grounds that he will not be able to deliver water to Oakland or Alameda, owing to the probability of law suits over his alleged water rights in Santa Clara County.

JACKSON, CAL.—An important suit has been commenced in the Superior Court at San Andreas, Calaveras county, by the California Storage Water Company vs. Ernest Krentz and 65 others, named as defendants, with some 40 John Does. The suit is with the object of condemning lands on the Calaveras river for the purpose of storing the floodwaters thereof, thereby generating electricity and supplying the towns of Valley Springs, Burson, Wallace, Jenny Lind and Milton, in Calaveras County, and Bellota, Linden, Lodi, Woodbridge, Peters, Farmington, Ripon, French Camp, Lathrop and Atlanta, in San Joaquin, with water for domestic purposes, besides irrigating an immense tract of new country. The location of the proposed dam is at a point six miles below Petersburg, where the country is low. The dam will be 175 feet in height and 1000 feet long, and built across the river bed. It has been estimated that such a dam would impound 20,000,000,000 cubic feet of water, holding the floodwaters of the Calaveras river.